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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, STATE GEOLOGIST

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

1913-1914

RALEIGH
E. M. UZZELL & CO., STATE PRINTERS AND BINDERS
1915

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., January 6, 1915.

To His Excellency, HON. LOCKE CRAIG,
Governor of North Carolina.

SIR:—I herewith submit my Biennial Report on the operations of the North Carolina Geological Survey for the years 1913 and 1914. I have included in this report several papers giving the results of investigations upon special subjects that have not been published, and yet, it is thought, should be printed and put in permanent shape. A financial statement covering the expenditures of the Survey for the two fiscal years is also part of the report.

Yours respectfully,

Joseph Hyde Pratt

State Geologist.

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BIENNIAL REPORT

OF THE

STATE GEOLOGIST

ON THE

OPERATIONS OF THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY FOR THE TWO YEARS ENDING NOVEMBER 30, 1914.

By JOSEPH HYDE PRATT, State Geologist.

INTRODUCTION.

The work of the North Carolina Geological and Economic Survey as outlined in the act* creating it is much more varied than the name would imply, as it embraces practically all investigations relating to the industrial advancement of the State, except those relating directly to agriculture.

The Geological Survey may be said to have been created for two distinct purposes:

1. To obtain all information possible regarding the various natural resources of the State and to work out plans and assist in the development and utilization of these resources.

2. To obtain information regarding the diverse conditions which are affecting these natural resources and to work out plans and remedies for conserving them.

Thus the report of the State Geologist becomes not only a report on the resources of the State and their uses, but also on recommendations

*Chapter 542, section 4, of the Public Laws of 1905.
The North Carolina Geological and Economic Survey shall have as its objects:
1. An examination of the mineral, forest, fishery, and other material resources of the State.
2. An examination of the geological formations of the State with reference to their economic products.
3. An examination of the road-building materials and the best methods of utilizing the same.
4. An examination and classification of the soils, the forests, and other physical features of the State, with special reference to their bearing upon the occupations of the people.
5. An examination of the streams and water-powers of the State, with special reference to the development for manufacturing enterprises and the preservation of the sources of these streams through the protection of the forests.
6. The consideration of such other scientific and economic problems as in the judgment of the Geological Board shall be deemed of value to the people of the State.
7. The preparation of such reports, illustrations, and maps as may be deemed necessary in placing the results of these investigations before the public.
8. And the State Geologist, with the approval of the Geological Board, is hereby authorized to arrange for and accept such aid and coöperation from the several United States Government bureaus and other sources as may assist in completing the topographic surveys of the State and in carrying out other provisions of this act.
9. An examination of the water supplies of the State, with special reference to the sinking of deep or artesian wells.

as to legislation that will conserve and increase the value of these resources to the State.

The State Geologist, in submitting these recommendations, does not wish to convey the idea that such recommendations will insure to the State all that is desired in regard to conserving its resources and its industrial advancement; yet he does believe that if the legislation recommended is passed it will very materially improve conditions that now exist in the State and pave the way for more adequate legislation.

It is only possible in this biennial report to give a brief description of the work that has been accomplished by the members of the Survey during the past two years, but detailed reports of the investigations and work done have been published as volumes, bulletins, economic papers, and circulars, and to these the members of the General Assembly are respectfully referred. A list of the publications of the Survey that have been printed and are ready for distribution are given at the end of this report.

The personnel of the North Carolina Geological and Economic Survey for the past two years has consisted of the following, who have been employed for either the whole or a part of their time:

Joseph Hyde Pratt, State Geologist and Engineer.

John E. Smith, Geologist.

J. S. Holmes, Forester.

W. S. Fallis, Highway Engineer.

T. F. Hickerson, Highway Engineer.

D. Tucker Brown, Highway Engineer.

J. M. Bell, Chemist.

Frank Drane, Chemist.

George M. Boyd, Drainage Engineer.

Miss H. M. Berry, Secretary.

R. P. Coble, N. C. Hughes, Jr., R. T. Brown, Ira Mullis, R. E. Snowden, J. C. M. Valentine, J. B. Clingman, C. M. Miller, Collier Cobb, Jr., Bascom Field, H. Hocutt, Sam D. Scott, Assistant Road Engineers and Superintendents.

Pearl Hildebrand, Nan McArn, Della Richardson, Mrs. E. S. McGehee, Carrie Moses, Margaret Berry, May G. Hume, stenographers.

Ernest Hutchins, W. A. Phillips, J. B. Lloyd, Ralph Andrews, B. D. Sykes, Ernest Kirkland, James Phipps, office assistants.

MINERALOGICAL AND GEOLOGICAL INVESTIGATIONS.

MINERALOGICAL INVESTIGATIONS.

The principal work done in connection with the minerals of the State is the collecting of statistics regarding its mineral production and a review of the general conditions of the mining industry and the output of mineral production. The collecting of these statistics of the mineral production of the State has been done in coöperation with the United States Geological Survey. The following is the form of agreement between the two surveys:

AGREEMENT FOR CO-OPERATION IN STATISTICAL WORK BETWEEN THE UNITED STATES GEOLOGICAL SURVEY AND THE GEOLOGICAL AND ECONOMIC SURVEY OF NORTH CAROLINA.

In order to avoid duplication of requests for statistical information covering mine and quarry operations, and also in order that the State Geologist may be kept in touch with the mineral producers of the State, the following agreement between the State Geologist and the Director of the United States Geological Survey is made for the collection of the statistics of mineral production (with the exception of gold, silver, copper, lead, and zinc) in 1910.

As soon as possible after the first of December a numbered list of the mineral producers in the State of North Carolina (duplicate of the list used by the Federal Survey) will be sent to the State Geologist, who will check with the data in his office and notify the Federal Survey of any additions or corrections. These corrections will be made on the list of the Federal Survey, properly numbered, and the State Geologist advised of the number.

The blanks for the collection of the statistics will be printed at the expense of the United States Geological Survey and stamped with the statement that the work is done in coöperation with the State Survey. The inquiries will be mailed from the United States Geological Survey, but will contain a franked envelope for the return of the reply to the State Geologist.

If the State Geologist finds any errors or omissions to correct, he will retain the original report and return a copy to the producer for the necessary correction, which correction, when received by the State Geologist, will be transferred to the original report. The latter will then be tabulated by him and forwarded immediately to the Federal Survey. The supply of blanks for securing these corrections will be furnished by the Federal Survey. If any additional corrections should be found necessary by the Division of Mineral Resources of the United States Geological Survey, they will be obtained by correspondence with the producers, and the State Geologist will be advised of any changes resulting therefrom.

The second and third requests for information will be prepared in the office of the Federal Survey in the same manner as the first request. The fourth request will be sent by registered mail after all attempts to secure returns by ordinary mail have been exhausted. The Director of the State Geological Survey will undertake to secure the reports of delinquents by personal visits of himself or his assistants.

Before any publication of results is made the totals for each subject will be submitted by the State Geologist to the Federal Survey for checking, and publication may be made by the State Survey as soon as the final figures are agreed upon. It is understood that in any preliminary or press notices thus issued, by either the Federal or the State Survey, credit for the coöperative plan will be given.

H. C. Rizer,
Acting Director United States Geological Survey.
Joseph Hyde Pratt,
State Geologist of North Carolina.

Formerly a special detailed report of the mining industry of the State was published each year, but now such a report is only brought out biennially. Each alternate year a short statement of the actual statistics of the mineral production is published in one of the press bulletins of the Survey.

The statistics for 1911 and 1912 were published in Economic Paper No. 34 and those for 1913 in Press Bulletin No. 132.

Mineral specimens are constantly being received at the Survey office for identification and analysis. While the majority of these do not represent anything of commercial or scientific value, yet occasionally one is found which does, and if there is any prospect of the mineral occurring in commercial quantity, the Survey assists in bringing the owner of the property in communication with those desiring such mineral. On the other hand, when the specimen proves to be of no commercial value, the Survey has, by notifying the sender of this, been able to save him the expense of chemical analyses and assays. The Survey makes no charge for the mineralogical determination of a mineral or rock, but if an assay or a chemical analysis is desired, a special charge is made for such work.

During the past two years about 264 samples of minerals have been examined and reported upon by the Survey. A few of these have been of considerable interest, as:

Cassiterite, from E. G. Morrison, Reidsville, N. C.

Black sand with good showing of gold, from Henry Scharffetter, Baltimore, Md. (Mineral from North Carolina.)

Halloysite, from D. Kresher and George Jackson, Morganton, N. C.

Sample of limestone, containing a new fossil (Chara), from C. M. McCorkle, Newton, N. C.

Talc and graphite, from F. R. Hewitt, Asheville, N. C.

Tourmaline, from Clarence Wilson, Bakersville, N. C.

Opalescent quartz and rhodolite, from E. G. Morrison, Reidsville, N. C.

Kaolin, from Walter Grimes, Cary, N. C.

Limestone, from W. H. Banck, Wilmington, N. C.

Magnetite, from V. E. Ballou, Grassy Creek, N. C.

Garnet and beryl, from W. E. Linney, Hiddenite, N. C.

Manganese ore, from R. E. Freeman, Dobson, N. C.
Alunogen, from D. M. Vernon, Spray, N. C.
Samarskite, from W. S. Deidrich, Toecane, N. C.
Limonite crystal pseudomorph after pyrite, from H. C. Freeman, Spray, N. C., and I. B. Linney, Hiddenite, N. C.
Clay, from E. C. Leonard, Greensboro, N. C.

In connection with the above mineralogical work, considerable information of interest and value to the work of the Survey relating to the occurrence of minerals in North Carolina is obtained; and this information will be used in the preparation of a general volume on the Mineral Resources of North Carolina.

GEOLOGICAL INVESTIGATIONS.

LIMESTONE DEPOSITS.

The General Assembly of 1913 passed an act* "To authorize the Board of Agriculture to make preparation to furnish lime to the farmers of the State for agricultural purposes at a reasonable cost." In section 4 of this act it says:

"The State Geologist, when requested by the Commissioner of Agriculture, shall have any property which it is proposed to purchase or lease examined and report as to the amount of material on the same, value, and further concerning the property as may be requested."

At the request of the Commissioner of Agriculture, examinations have been made of marl and limestone deposits at the following localities:

Winton deposit, six miles northwest of Winton, on the farm of Mr. G. T. Darden of Ahoskie.

Washington deposit, two miles northeast of Washington, Beaufort County.

Rocky Point deposit, two miles east of depot, on the farm of Mr. N. M. McEachern.

New Bern deposit, four miles southwest of New Bern, on Trent River, owned by the Chemical Lime Company.

Woodside deposit, one and one-half miles east of Woodside, on the farm of Mr. J. C. Nixon.

Old Limestone Quarry, five miles south of Catawba, Catawba County, on land belonging to the Trollinger estate.

The reports on these properties, which have been made by the State Geologist and Mr. John E. Smith, Assistant Geologist, have been filed with the Commissioner of Agriculture.

*Chapter 87, Public Laws of 1913.

A rather extensive examination has also been made of the shell-lime deposits of the Trent River, extending up the river for about eight miles above New Bern. Other deposits have been examined in Bladen, Columbus, and New Hanover counties.

As a result of these examinations, it is now realized that the deposits of marl and limestone are much more extensive than were formerly considered, and that a thorough and systematic investigation of such deposits of the State is warranted. A considerable percentage of the limestone of Western North Carolina is dolomitic in character, and for this reason the deposits of this type of limestone have been considered of much less value for agricultural purposes than the lime limestone. However, recent reports of the Department of Agriculture indicate that a dolomitic limestone will make a good fertilizer, and there is, consequently, an increasing demand for ground limestone of this type. This is another reason for a thorough investigation of the lime deposits of the State.

COASTAL PLAIN REGION.

In connection with the preparation of Volume III on *The Coastal Plain Region of North Carolina and Its Resources,* which has already been published, a great deal of valuable and interesting data were collected relating to the paleontology of the district. Although this information will have little or no commercial value, as it relates principally to a study of fossils, it is of very great scientific interest and of considerable value to the geological history of North Carolina. Preparations are being made for the publication of this information as a volume on the *Paleontology of the Coastal Plain Region.* The preparation of this volume is being carried on in coöperation with the United States Geological Survey, and it may be another year before the volume will be ready for publication. The fossils are being worked up by several geologists, including Dr. William Bullock Clark, Mr. T. Wayland Vaughan, Dr. L. W. Stephenson, Dr. C. W. Gilmore, Dr. E. W. Berry, Dr. Benjamin L. Miller, Dr. A. C. True, and Dr. Julia A. Gardner. Dr. Gilmore has already completed his chapter on the fossil reptiles; Dr. Berry has nearly completed his on the fossil plants, and Miss Gardner is well advanced in her work on the tertiary fossils.

GOLD MINES.

There has been considerable renewed interest in gold mining in North Carolina, and during the past two years a study has been made of the gold ores occurring in the slates of the Carolina gold belt. The results of this investigation have been published in Economic Paper 34 on the

Mining Industry of North Carolina. This investigation has demonstrated that the gold ores in these slates are continuous with depth and can be mined profitably.

IRON DEPOSITS.

Investigation has also been made of the magnetic iron ores of Ashe County. On account of the lack of transportation facilities, there has been but little development of these ores, but since the construction of the railroad across Ashe County, these iron ore deposits are given very satisfactory transportation facilities, and there is no question now but that they will be developed. A report on the investigation of these magnetic iron ores has been published in Economic Paper 34.

WORK OF THE UNITED STATES GEOLOGICAL SURVEY.

In addition to the coöperative work that has been carried on between the Federal and the State Surveys, the United States Geological Survey has made the following investigations in the State during the past two years:

In 1914 a report by L. W. Stephenson, on *Cretaceous Deposits of the Eastern Gulf Region, and Species of Exogyra from the Eastern Gulf Region and the Carolinas,* was published as Professional Paper 81. The Pliocene foraminifera of the State are described in a report submitted by Joseph A. Cushman, and a report in which the foraminifera of the Miocene will be described is nearing completion.

A monograph on the *Cretaceous Mollusca of North Carolina,* by L. W. Stephenson, to be published as a coöperative report by the State Survey, is nearly completed.

A report on the *Tertiary Paleontology of Virginia and the Carolinas* is now in preparation by Miss Julia Gardner of Johns Hopkins University and several collaborators who are connected with the United States Geological Survey. This monograph, which is far advanced, is designed for publication by the Federal Survey, although most of the expense of its preparation has been borne by the State Survey.

Under the auspices of the Section of Eastern Areal Geology, the areal and economic survey of the Kings Mountain and Gaffney quadrangles was continued by D. B. Sterrett during the fall of 1912. Much time was devoted by Mr. Sterrett during the office season of 1912 and 1913 to the compilation of his field notes for publication in a folio to cover these quadrangles. The mapping of the geology in these quadrangles was inspected by Arthur Keith, Chief of the Section, during the fall of 1913. During the fiscal year 1914-1915 Mr. Sterrett continued work at inter-

mittent periods, mostly during the summer months, on his maps and notes for the above-named folio, the field work for which has been completed.

During the field season of 1913 and 1914 Mr. Sterrett completed the areal and economic survey of the Lincolnton quadrangle, about 100 square miles having been mapped in detail. A reconnaissance of about 100 square miles was made in adjoining quadrangles. During the office season of that year Mr. Sterrett was engaged from time to time in the preparation of his material, to which work he also devoted the period from July 30 to November 30, 1914. The Lincolnton area was inspected by Mr. Keith during the fall of 1913.

In the spring of 1914 a brief investigation was made by Mr. Sterrett in the Morganton quadrangle to determine the nature of some reported unusual lights on Brown's Mountain.

Either in connection with the preparation of reports on mineral resources or as a part of broad investigations of certain nonmetalliferous deposits, minor examinations have been made by Mr. Sterrett, who, in November, 1913, spent several days in examining the mica deposits of Iredell and Yadkin counties. Also in November, 1914, Mr. Sterrett spent about one-third of the month in the examination of mica deposits in the State.

In October, 1913, W. C. Phalen visited power installations of the Aluminum Company of America and the Southern Aluminum Company, Salisbury and Whitney, North Carolina.

In October, 1914, T. Nelson Dale spent a day or two in Murphy and vicinity, examining marble deposits.

MAPPING OF THE STATE.

TOPOGRAPHIC WORK.

The only topographic mapping that has been done during the past two years in North Carolina has been by the United States Geological Survey. The State Survey had no appropriation available with which to coöperate in this work; consequently, the amount of topographic work done this year is less than in previous years.

The Survey of the Belhaven and Kinston quadrangles, in Beaufort, Hyde, Washington, Greene, Lenoir, and Pitt counties, was completed, and that of the Gastonia quadrangle, in Gaston, Lincoln, and Mecklenburg counties, was commenced by G. S. Smith, J. M. Whitman, W. H. S. Morey, R. L. Harrison, R. A. Kiger, J. H. LeFeaver, J. B. Metcalfe, Jr., and Roscoe Reeves. The total area mapped was 647 square miles, for publication on the sale of 1:62,500, with a contour interval

of 20 feet. For the control of these areas and of the Bunyon quadrangle, in Beaufort and Martin counties, G. T. Hawkins and C. W. Arnold ran 170 miles of primary traverse and set 20 permanent marks, and Mr. Metcalfe, Mr. Arnold, and R. H. Kilmer ran 165 miles of primary levels and established 31 permanent bench marks.

In the Biennial Report of the State Geologist for 1909-1910 there is given, on pages 20-22, a list of the topographic maps, covering portions of North Carolina, that have been published, together with the portions of counties that they cover.

COUNTY MAPS.

Many inquiries have been received from county commissioners regarding the preparation of county maps similarly as were published several years ago of Beaufort, Pitt, and Franklin counties. The State Survey has not been in a position to coöperate with the counties in the preparation of these maps, as formerly, on account of lack of funds, because the United States Geological Survey repealed a ruling relating to the coöperation that had been in force for several years between the State and Federal Surveys in preparing traverse maps of the various counties. Now the Federal Survey will only coöperate with the State Survey when the coöperation extends to the preparation of a topographic map of the county. As these topographic maps will cost from $2,500 to $7,500, according to the size of the county, it is impossible for the State Survey to take up any coöperative work unless there is a special appropriation for this purpose.

The State Geologist has, however, advised with the commissioners of several counties in regard to specifications for traverse maps.

SOIL SURVEY MAPS.

In making the soil surveys of the various counties of North Carolina, it is necessary that traverse maps of these counties be prepared. When the Topographic Division of the United States Geological Survey was coöperating with the State Survey in map work several county traverse maps were prepared. As stated in "Topography," however, on account of the ruling made by the United States Geological Survey, it is impossible now for the State Survey to make these traverse maps without a direct appropriation from the State for this purpose. If such maps could be prepared of all the counties, it would greatly reduce the cost of the soil surveys to the Department of Agriculture, under whose administration these surveys are made in North Carolina in coöperation with the United States Bureau of Soils.

North Carolina State Library
Raleigh

These soil survey maps and reports are of great value to the counties of the State, and it is hoped that the State can make a special appropriation for mapping which will enable a greater number of counties to be surveyed each year than it has been possible to make in preceding years.

Thus far the following soil surveys have been made in North Carolina:

List of Soil Survey Maps.

Year.	Area.
1901	Alamance County.
1912	Ashe County.
1903	Asheville area (parts of Buncombe, Madison, and Haywood counties).
1910	Cabarrus County.
1901	Cary area (part of Wake County). (Exhausted.)
1908	Caswell County.
1906	Chowan County.
1903	Craven area (parts of Pitt, Craven, and Jones counties).
1905	Duplin County.
1907	Edgecombe County.
1913	Forsyth County.
1909	Gaston County.
1910	Granville County.
1904	Greenville area, Tennessee (part of Madison County, N. C.).
1907	Henderson County.
1902	Hickory area (parts of Catawba, Lincoln, Burke, Caldwell, Alexander, and Iredell counties). (Exhausted.)
1911	Johnston County. (In progress.)
1909	Lake Mattamuskeet area (parts of Hyde County).
1909	Mecklenburg County.
1902	Mount Mitchell area (parts of Yancey, Mitchell, Madison, Buncombe, and McDowell counties). (Exhausted.)
1906	New Hanover County. (Exhausted.)
1905	Pasquotank and Perquimans counties. (Exhausted.)
1912	Pender County.
1909	Pitt County.
1900	Raleigh to New Bern (parts of Craven, Jones, Wake, Johnston, Wayne, Greene, and Lenoir counties). (Map exhausted.)
1911	Randolph County. (In progress.)
1911	Richmond County. (In progress.)
1908	Robeson County.
1909	Scotland County.
1901	Statesville area (parts of Iredell, Mecklenburg, Lincoln, Catawba, and Rowan counties).
1906	Transylvania County.

HIGHWAYS.

The Highway Division of the North Carolina Geological and Economic Survey has been pushed to the utmost in trying to give information and assistance regarding the location, construction, and maintenance of roads, which is constantly being demanded of it. There have been as many as twenty-eight requests for engineering assistance in the office at one time, and it has been absolutely impossible to give the desired assistance on account of lack of funds. The only appropriation thus far

made for carrying on the work of this division of the Survey is $5,000 annually, which is totally inadequate to carry on the work that is demanded of the Survey. As stated in section 2 of chapter 915 of the Public Laws of 1909:

"The object and purpose of this appropriation shall be to enable the North Carolina Geological Board to advise with the township and county authorities in the building and improvement of the public roads, by sending to the township or county a competent road engineer, who will assist them in locating their improved roads, advise them as to the best road to build and how to build it, and also give advice relating to the best kind of bridge to be built in connection with the improvement of any road. The Geological Board, through the State Geologist, may make inquiries in regard to systems of road building and management throughout the United States, and make investigations and experiments in regard to the best kinds of road materials, and shall disseminate such knowledge by lectures to be given in the different counties and by preparing, publishing, and distributing bulletins and reports on the subject of road improvement, and shall also gather and tabulate information and statistics on road building in North Carolina and disseminate the same throughout the State."

In addition to the work required by this act, several acts were passed at the regular session and the special session of the General Assembly in 1913 requiring still more work of the Survey.

The $5,000 appropriated by the State has been very largely supplemented during the past two years by most hearty and cordial coöperation of the United States Office of Public Roads, The National Highways Association, the North Carolina Good Roads Association, and individuals. The result has been that the State Survey has thus been enabled to give three to four times more engineering assistance to counties in road work than it otherwise would have been able to do. Also by means of this assistance, a great many miles of good roads have been constructed that otherwise would not have been attempted. It has also been the means of preventing the unwise expenditure of hundreds of thousands of dollars of money raised by the various counties for the construction of good roads. It has unquestionably demonstrated the fact that the expenditure by the State of a sufficient amount to give to all the counties and townships the engineering assistance needed by them in their road work would be one of the wisest appropriations that the State could make.

While it has not been possible to give the assistance desired by counties in regard to location and construction and maintenance of their

roads, yet every possible consideration has been given to all requests for such assistance as they have been received at the Survey office; but in many cases it was only possible to give but a small per cent of the assistance actually needed. Many times the engineers have only been able to spend a day or two in a county, whereas if the funds had been available it would have been much better if they could have given weeks or even months in working out road problems in a particular county.

The work of the Highway Division is of two distinct types, educational and engineering.

EDUCATIONAL WORK.

One of the problems of highway work in the State yet to be solved is the question of the maintenance of the good roads after they have been constructed. This question is being agitated by the various members of the Survey staff in the addresses that they make in different parts of the State, and all road authorities are being urged to make provision to begin the maintenance of the road as soon as it has been constructed.

The State Geologist and assistants have made, during the past two years, good road addresses at the following places:

STATE GEOLOGIST at—

Roxboro, Person County	January	6, 1913
Sanford, Lee County	January	7, 1913
Lumberton, Robeson County	January	18, 1913
Asheville, Buncombe County	February	12, 1913
Lexington, Davidson County	February	25, 1913
Thomasville, Davidson County	February	25, 1913
Washington, D. C. (second annual Federal Aid Congress)	March	6, 1913
Bat Cave, Henderson County	March	31, 1913
Rutherfordton, Rutherford County	April	7, 1913
Henderson, Vance County	April	19, 1913
Tarboro, Edgecombe County	June	6, 1913
Greensboro, Guilford County (before Summer School, A. and M. College)	July	17, 1913
Hickory, Catawba County	July	28, 1913
Cary, Wake County	July	29, 1913
Morehead City, Carteret County	July	31, 1913
Cary, Wake County	August	5, 1913
Holly Springs, Wake County	August	6, 1913
Statesville, Iredell County (annual meeting of N. C. Association of County Commissioners)	August	13, 1913
Denton, Davidson County	September	8, 1913
Raleigh, Wake County (before Chamber of Commerce)	September	9, 1913

Littleton, Warren County---September 12, 1913
Norlina, Warren County---September 13, 1913
Raleigh, Wake County (special session of N. C. Good Roads Association)---September 24, 1913
Granite Falls, Caldwell County---September 26, 1913
Detroit, Michigan (American Road Congress)---October 2, 1913
Asheville, Buncombe County---October 22, 1913
Asheville, Buncombe County---November 7, 1913
Marshall, Madison County---November 8, 1913
Bat Cave, Henderson County---December 4, 1913
Bristol, Tennessee---December 5, 1913
Mountain City, Tennessee (in interest of highway from Boone, N. C., to Mountain City, Tenn.)---December 6, 1913
Philadelphia, Pennsylvania (American Road Builders' Association)---December 10, 1913
Marshall, Madison County---December 29, 1913
Atlanta, Georgia (Division of Economics of the American Association for the Advancement of Science)---December 31, 1913
Whiteville, Columbus County---February 7, 1914
Richmond, Virginia---February 10, 1914
Bat Cave, Henderson County---February 25, 1914
Knoxville, Tennessee (two lectures before Institute of Highway Engineering at the University of Tennessee)---February 27, 1914
Durham, Durham County (meeting of Durham County Commissioners)---March 3, 1914
Chapel Hill, Orange County (before Good Roads Institute)---March 18, 1914
Atlanta, Georgia (Georgia Association of County Commissioners)---April 15, 1914
Roxboro, Person County---May 4, 1914
Three other addresses, Person County (in interest of bond issue)---May 4-5, 1914
Cary, Wake County (mass-meeting)---July 4, 1914
Durham, Durham County (before N. C. Good Roads Association)---July 9, 1914
Asheville, Buncombe County (meeting of Board of Trade)---August 18, 1914
Wilkesboro, Wilkes County (mass-meeting in interest of county road law)---October 5, 1914
Bristol, Virginia (Southern Appalachian Good Roads Association)---October 7, 1914
Bryson City, Swain County (mass-meeting in interest of Asheville-Murphy Highway)---October 13, 1914
Chapel Hill, Orange County (Rally Day, Orange County)---October 16, 1914
Atlanta, Georgia (American Road Congress)---November 9, 1914
Wilmington, New Hanover County (Corn Show)---November 13, 1914
Newport, Tennessee (interest of Central Highway)---November 21, 1914

North Carolina State Library

D. Tucker Brown at—

Whiteville, Columbus County, county overseers and supervisors	February	7, 1914
Norlina, Warren County, citizens	February	18, 1914
Mebane, Alamance County, citizens	February	24, 1914
Oxford, Granville County, Board of Trade	February	26, 1914
Wilmington, New Hanover County, Board of Trade	April	7, 1914
Mount Gilead, Montgomery County, citizens	April	21, 1914
Burlington, Alamance County, citizens	April	29, 1914
Roxboro, Person County, citizens. (A number of addresses were made in Person in interest of a bond issue)	Part of April and May,	1914
Goldsboro, Wayne County, Board of Trade	June	12, 1914
New Bern, Craven County, Board of Trade	June	18, 1914
Liberty, Randolph County, citizens (bond issue)	June	20, 1914
Hassell, Martin County, citizens (bond issue)	July	6, 1914
Asheville, Buncombe County, Board of Trade	August	18, 1914
Waynesville, Haywood County, Board of Trade	September	21, 1914
Sylva, Jackson County, Board of Trade	September	22, 1914
Franklin, Macon County, citizens	September	23, 1914
Andrews, Cherokee County, citizens	September	24, 1914
Bryson City, Swain County, Board of Trade	October	13, 1914
Murphy, Cherokee County, citizens	October	15, 1914

H. B. Varner at Lenoir, Caldwell County; Lexington, Thomasville, and Denton, Davidson County; Mocksville, Davie County; Lincolnton, Lincoln County; Ashboro, Randolph County; Danbury, Stokes County; Dobson, Surry County; Dunn, Harnett County; Wendell, Wake County; Enfield, Halifax County; Gilreath, Wilkes County.

M. H. Stacy at Schoolhouse in Davidson County; Albemarle, Stanly County; Capella, Stokes County.

T. F. Hickerson at Oxford, Granville County.

James A. Wellons at Cameron, Moore County; Tarboro, Edgecombe County; Norlina, Warren County.

W. L. Spoon at Rural Hall, Stokes County.

D. H. Winslow at Jefferson, Ashe County.

GOOD ROADS INSTITUTE.

Perhaps the most important line of educational work undertaken by the Survey was the holding of a Good Roads Institute at Chapel Hill, March 17, 18 and 19, 1914. The institute was called by the Survey and the University of North Carolina, and was attended by forty-four engineers, superintendents, and foremen, representing thirty counties. Those attending showed a great deal of interest in the discussion of road problems that were taken up, and before the close of the institute a resolution was unanimously passed requesting the president of the University and the State Geologist to arrange to hold the Institute annually.

The Proceedings of the Institute have been published as Economic Paper 39, and make a valuable addition to the literature relating to highway construction.

It is hoped and expected that this Institute can become a clearing house for the road problems of North Carolina.

During the past year the State Geologist has assisted the Department of Civil and Highway Engineering in the University to equip a highway engineering laboratory. This was completed in time to be open for the members of the Institute. The laboratory will be used, not only by the engineering students of the University, but by the engineers of the Survey.

ENGINEERING ASSISTANCE TO COUNTIES.

The engineering assistance that has been rendered to the various counties and townships of North Carolina by the road engineers connected with the Survey has carried them into all parts of the State, and the beneficial results of their work are to be seen in the increased efficiency of the road work throughout the State.

The engineering assistance has been carried on largely in coöperation with the United States Office of Public Roads, and has consisted of:

1. Location of particular highways.
2. Advice regarding the best road to build, and how to build it.
3. The construction of short sections of sample road.
4. The inspection of bridges.
5. The inspection of roads in regard to maintenance.

There is given below a short statement regarding the engineering work done during the past two years.

By State Geologist:

General supervision of the construction of the Hickory Nut Gap Highway, Henderson County.
Inspection of location for certain highways in Madison County, and inspection of work of State convicts in Madison County.
Inspection of certain roads (sand-clay) in Columbus and Wilson counties.
Inspection of bituminous bound gravel road in New Hanover County.

By D. Tucker Brown:

February, 1914.

Investigated highway between Mebane and Haw River.
Inspected roads in Columbus County.
Inspected roads in New Hanover County with the county superintendent.
Inspected quarry site for macadam, New Hanover County.
Located road leading northwest of Norlina, Warren County.
Inspection of roads in Warrenton Township, Warren County, and conference with commissioners regarding method of working their roads.

March, 1914.

Met with Alamance county commissioners and advised regarding road from Mebane to Haw River.

Located and inspected location of roads in Madison County.

Inspected road work in Warrenton Township.

Located road between Mebane and Haw River.

Assisted superintendent to locate road in Warrenton Township.

April, 1914.

Investigated location of roads near Mount Gilead, Montgomery County.

May, 1914.

Inspected location of road at Danbury, Stokes County.

Inspected location of road near Burlington, Alamance County.

Inspected condition of road and suggested repair of same at Reidsville, Rockingham County.

Completed survey of road leading west of Burlington, Alamance County.

July, 1914.

Investigated road conditions in Forsyth, Davie, and Iredell counties along the route of the road to be built coöperatively with the Federal Government. This examination was with Mr. Dodge, of the United States Office of Public Roads.

Made examination of road work on Hickory Nut Gap Road.

Inspected the following roads in Randolph County:

Ashboro-Biscoe,
Ashboro-Tabernacle,
Ashboro-Ramseur,
Ashboro-Farmer,
Ashboro-Greensboro.

Made examination of road work in Murphy Township, Cherokee County, and suggestions regarding the proper course to be pursued in connection with any future work.

Inspected roads in Jacksonville Township, Onslow County, and advised township commissioners in regard to the expenditure of their $10,000 bond issue.

Inspected road work in the town of Mebane, Alamance County.

August, 1914.

Special investigations regarding location of portion of the Central Highway in Madison County.

September, 1914.

One week was spent in locating portion of highway in Madison County.

October, 1914.

One week was spent in locating portion of highway in Madison County.

Inspected road work in Warrenton Township, Warren County.

November, 1914.

Inspection of road work by State convicts in Madison and Henderson counties.

By T. F. Hickerson:

February, 1913.

Inspected road surfacing material near Albemarle, Stanly County.

March, 1913.

Inspected gravel road extending from Ashboro to Moore County line, and reported on the condition of the location and method of surfacing, making tests at intervals to determine the thickness of the gravel.

May, 1913.

Surveyed location for road near Bynum, Chatham County.

September, 1913.

Inspected location for road from Tryon to Saluda.

October, 1913.

Made survey for relocation of road from Burlington to Belmont, Alamance County.

Lecture on "Road Improvement" at Stem, Granville County.

Lecture on "General Principles of Road Building" at Oxford, Granville County.

November, 1913.

Made survey for relocating part of road from Graham to Snow Camp, Alamance County.

January, 1914.

Assisted in making survey for relocation of Chapel Hill-Durham road, Orange County.

February, 1914.

Supervised construction of a gravel road along a section of Franklin Street, Chapel Hill.

Made a survey of another section of road between Graham and Snow Camp, Alamance County; prepared plans and profile.

March, 1914.

Assisted in location of bridge abutments and wing walls for bridge at Strowd's Creek on the Chapel Hill-Durham road, Orange County.

April, 1914.

Inspected location of portion of highway between Ashboro and Farmer, Randolph County.

Made preliminary survey for road from Ashboro towards Bennetts, Randolph County.

October, 1914.

Assisted in making preliminary survey for road from Chapel Hill toward Blackwood, Orange County.

By R. P. Coble:

Location of five miles of road in Harnett County, between Olivia and Fairview.

Location of several roads in Randolph County.

By J. C. M. Valentine:

Survey and location of road from Lake Toxaway to White Water River, Jackson County.

Superintendent of road work on Hickory Nut Gap Road in Henderson County, September, 1913, to November, 1914.

By W. S. Fallis:

March, April, and May, 1913.

Made complete location of the Hickory Nut Gap Road from the Rutherford County to the Buncombe County line, a distance of seven and one-quarter miles.

By R. E. Snowden:

August, 1914.

Inspected road conditions in Sampson County, and made recommendations as to how they should be worked and surfaced; also made recommendations as to road machinery that could be used to advantage in this county.

By J. B. Clingman:

April, 1913.

Inspected location for road between Sylva and Cullowhee, Jackson County. Also investigated source of supply of surfacing materials.

August and September, 1913.

Superintendent of road work on Hickory Nut Gap Road.

October, 1913, to April, 1914.

Location of roads in Madison County.

By Ira B. Mullis:

January, 1913.

Inspected road conditions in Toisnot Township, Wilson County, and made recommendations regarding location and surfacing of its roads.

Location of road near Pee Dee, Anson County, and inspection of site for bridge, with estimate of cost of same.

By Bascom Field:

November, 1913.

Located road at Buie's Creek, which was worked by volunteers on Good Roads Days, November 4th and 5th.

August, 1914.

Superintended the grading of road from Mebane to Trollingwood, Alamance County.

September, 1914.

Located road near Burlington, Alamance County.

By Collier Cobb, Jr.:

Supervision of road work, Chapel Hill Township, Orange County, July-November, 1914.

By H. W. Collins:

Supervision of road work, November 5 and 6, 1913, at Carrboro.

While it has been impossible for the Highway Division of the Survey to give all the engineering assistance requested, we have attempted in every case to provide in some way so that the counties and townships that have road funds to spend shall be supplied with a competent engineer to supervise the work. One plan adopted is to have placed in a

township or county desiring assistance a man competent to superintend the work and carry out the instructions of one of our chief highway engineers, this engineer to locate the roads and visit the township or county once or twice a month to inspect and supervise the work of the superintendent.

The county or township pays all salary and expenses of the resident engineer or superintendent. In this way the county or township obtains satisfactory highway engineering assistance at a considerably less cost than if they were obliged to employ a highway engineer permanently. This arrangement is working very satisfactorily in several parts of the State and is right in line with the work of the Highway Department that is recommended to be authorized by the General Assembly of 1915.

It is a safe estimate to make that the engineering assistance which the Highway Division of the Survey has been able to render the counties and townships of the State has saved to them and therefore to the State at least $100,000 each year for the past two years, and that if an adequate appropriation were made to this Division this saving could be increased four or five times this amount each year.

A great deal of advice and general information regarding local road problems has been given by correspondence, this being especially true in regard to road materials. Such information has been extended to Buncombe, Burke, Caswell, Craven, Henderson, McDowell, Orange, Polk, Rockingham, Rutherford, Wake, Warren, Washington, and Wilkes counties.

SPECIAL ACTS RELATING TO HIGHWAY WORK.

At the General Assembly of 1913 the following law relating to the construction of the Hickory Nut Gap Road was passed:

AN ACT TO PROVIDE FOR THE CONSTRUCTION OF THE HICKORY NUT GAP ROAD.

The General Assembly of North Carolina do enact:

SECTION 1. That that part of the Hickory Nut Gap Road extending from Rutherfordton to Asheville, and lying in Henderson County from a point where said road intersects the Henderson-Rutherford County line to the point where said road intersects the Henderson-Buncombe County line in or near Hickory Nut Gap, is herewith declared to be a State road, to be under the supervision of a board of commissioners hereinafter provided for, after said road has been located and constructed. Road declared State road. Supervision.

SEC. 2. That the location of said portion of the Hickory Nut Gap Road lying in Henderson County within the boundaries as described in the preceding section shall be made by the Highway Division of the North Carolina Geological and Economic Survey, and said Highway Division shall also prepare plans and specifica- Location of roads. Plans and specifications.

State to furnish convicts.

tions for the construction of said road; and the Council of State is herewith instructed and directed to furnish as many convicts as practicable, and not less than thirty, who shall be used in the construction of said road according to the said plans and specifications, and under the supervision of a highway engineer of the

Detail of convicts.

North Carolina Geological and Economic Survey. Said convicts shall be detailed for this work on or before July first, one thousand nine hundred and thirteen.

Expense of convict force.

SEC. 3. That the cost of guarding, keeping, clothing, and all other expenses of the convicts detailed for such road work herein provided for shall be paid by the penitentiary authorities.

Appointment of road commissioners.

SEC. 4. That as soon as the said road has been completed, and such fact is certified by the Highway Division of the North Carolina Geological and Economic Survey to the boards of county commissioners of Buncombe, Henderson, and Rutherford counties, it shall then be and herewith becomes the duty of the boards of county commissioners of said counties to appoint one man each from their respective counties, who shall be a member of the Hickory Nut Gap Road Commission, which is herewith created, whose duties shall be to provide the means for and supervise the

Meeting and organization.

maintenance of said road. As soon as practicable after their appointment, the said members of the said commission shall meet at Bat Cave, Henderson County, and organize by electing one of their members chairman and another secretary and treasurer.

Annual meetings.

The said commission shall meet at such times and places as may become necessary in attending to their duties and in carrying out

Estimate and apportionment of cost of maintenance.

the provisions of this act. The said commission shall meet on the first Monday in March of each year and estimate the probable cost for maintaining the said road for the current year, and apportion this amount equally between the counties of Buncombe,

Appropriation by counties.

Henderson, and Rutherford, which apportionment shall be certified by the secretary of said Hickory Nut Gap Road Commission to the chairman of the board of county commissioners of each of said counties, and thereupon it shall become the duty of the boards of county commissioners of said counties to appropriate out of the general treasury of their respective counties the amount certified by the secretary of the Hickory Nut Gap Road Commis-

Qualification of members.

sion, and they shall forward the same to said secretary. That the members of said commission shall be men who are favorable and friendly to said road, and who shall serve without compensation.

Method of maintenance.

Warrants on funds.

The method of maintaining said highway shall be determined by the said Hickory Nut Gap Road Commission. That the funds in the hands of said commission shall be paid out by the treasurer on warrant signed by the chairman.

SEC. 5. That all laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 6. That this act shall be in force from and after its ratification.

Ratified this the 7th day of March, A. D. 1913.

(Chapter 539, Public-Local Laws of 1913.)

According to this act, the Geological and Economic Survey had a survey made of a road leading from the Rutherford County line to the Buncombe County line via Bat Cave, and located the most practicable route for a highway. In the latter part of August, 1913, the Council of State detailed fifty convicts to construct this Hickory Nut Gap Road. Not all of these convicts were available for road work on account of injuries that they had received, which, in some cases, made them of no assistance whatever in road work. Others of the convicts were required for work around the camp, so that the actual number of convicts available for road work has varied from thirty-one to forty-five per day. The average for the time the convicts have been at work on the road is approximately thirty-three per day.

The construction work has been under the direct supervision of the Geological and Economic Survey, and they have had one of their engineers constantly in charge of the work. The State Geologist himself has kept in close touch with the work and has had general supervision of all the work. In order to supplement the work of the convicts, it was necessary to raise a fund of $5,000 to $7,000 and this was accomplished partly by private subscription and partly by a bond issue of Edneyville Township. Of the township bond issue, $1,500 was appropriated to the Hickory Nut Gap Road. Approximately $3,600 has been raised by private subscription by a committee composed of the following:

HICKORY NUT GAP ROAD COMMITTEE.

Dr. M. H. Fletcher	Asheville, N. C.
S. B. Morse	Hendersonville, N. C.
J. L. Ashworth	Fairview, N. C.
Dr. C. M. McCracken	Fairview, N. C.
J. M. Lyda	Edneyville, N. C., R. F. D.
C. W. Keeter	Rutherfordton, N. C.
John Nichols	Rutherfordton, N. C.
F. L. Flyn	Uree, N. C., R. F. D.
C. Oates	Bear Wallow, N. C.
M. L. Williams	Bat Cave, N. C.
W. F. Pryor	Bear Wallow, N. C.
J. B. Freeman	Bat Cave, N. C.
J. M. Flack	Bat Cave, N. C.
Mack Whiteside	Uree, N. C.
L. Logan	Chimney Rock, N. C.
R. E. L. Freeman	Gerton, N. C.

The success of this committee in raising the necessary funds was due largely to the energy and enthusiasm of Dr. M. H. Fletcher, of Asheville, North Carolina. During the first two months of the work, Mr.

J. B. Clingman was resident superintendent. From October, 1913, to October, 1914, the superintendent in charge was Mr. J. C. M. Valentine. He resigned October 1st to take a position with the Federal Government. His successor is Mr. H. Hocutt, who is now in charge of the work, as superintendent.

The State Geologist has inspected the work on an average of once a month, and by weekly reports has kept in close touch with it.

There is no question but what the convicts have been able to construct a first-class road and at a cost that compares very favorably with any other work done in the State, either by contract or by the day. The total cubic yardage removed in constructing the Hickory Nut Gap Road to date is 72,720 cubic yards. Of this amount, 10,200 cubic yards were of solid rock. Reckoning the value of the convict labor at $1.25 per day for each convict, and taking into account all other costs, as superintendent's salary, foremen's salary, teams, cost of pipe, etc., the average cost per cubic yard has been 28½ cents. Plate I, and Plate II A and B, are illustrations of the work done by the convicts.

Summary of Work on Hickory Nut Gap Road.

From the time the work was begun by the State convicts to November 30, 1914, the approximate cost of the work is as follows:

Foremen	$ 827.40
Blacksmithing	110.85
Value of teams used	406.87
Powder (13,157 pounds)	1,963.55
Value of convict labor (14,580 day men at $1.25 per day)	18,225.00
Engineer (thirteen months)	1,950.00
Total	$23,483.67

The amount of work accomplished was as follows:

Excavation ---- 62,320 cu. yds. earth,
10,400 cu. yds. rock.

Clearing 18 acres on right of way.
Building 17 rock culverts.
Building 8 bridges.

Estimating the cost of clearing the 18 acres, at $40 per acre, or $720, and the cost of the construction of the culverts and the abutments for bridges $2,038, this would make the cost of the excavation unclassified at 28 5/10 cents per cubic yard, which, considering the amount of solid rock excavated, is an extremely reasonable figure.

Hickory Nut Gap Road Near Bat Cave.
Built by State Convicts.

A. Hickory Nut Gap Road.
Heavy Rock Work. Built by State Convicts.

B. Hickory Nut Gap Road.
Built by State Convicts.

MADISON COUNTY ROAD.

Another act* passed by the General Assembly of 1913 relating to the working of State convicts on a certain road in Madison County is as follows:

Whereas the State of North Carolina granted a charter to the Western Carolina Railway Company (now Southern Railway Company), allowing said railroad company to confiscate and use as its roadbed and right of way a public highway along the French Broad River through Madison County, which has been kept up and maintained by the people of that county for many years; and whereas the State of North Carolina has realized a large sum of money from said right of way and continues to collect a large annual tax from said railroad company; and whereas the townships in said county which have been deprived of their road as aforesaid are unable to rebuild the same, but stand ready and willing to aid in the construction thereof; and whereas the State is morally obligated to replace said road, for the reasons aforesaid, and of right ought to do so without delay; and whereas the construction of said road will open up a thoroughfare for through travel from all the principal cities of North Carolina to important points in Tennessee and the west, to the great convenience and advantage of all the people of this State: Now, therefore,

Preamble: donation by State of highway to railroad.

Preamble: large amount realized by State.

Preamble: townships willing to aid.

Preamble: moral obligation on State.

Preamble: road of great convenience and advantage.

The General Assembly of North Carolina do enact:

SECTION 1. That the North Carolina Geological and Economic Survey is hereby authorized, empowered, and directed to forthwith make a survey and to locate a public road in Madison County, to take the place of the road so occupied by the railroad company, and to prepare plans and specifications for the construction of the same.

Survey and location directed.

Plans and specifications.

SEC. 2. That the Council of State is herewith instructed and directed to furnish as many State convicts as practicable, not less than twenty-five, who shall be used in the construction of said road according to the plans and specifications made by and under the supervision of a highway engineer of the North Carolina Geological and Economic Survey. Said convicts shall be detailed to work on or before the first day of June, one thousand nine hundred and thirteen, and shall construct at least fifteen miles of said road.

State to furnish convicts.

Detail of convicts.

Amount of work.

SEC. 3. That the cost of guarding, keeping, clothing, and all other expenses for the convicts detailed for such work herein provided for shall be paid by the penitentiary authorities.

Expenses of convicts.

SEC. 4. All laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 5. This act shall be in force from and after its ratification.

Ratified this the 6th day of March, A. D. 1913.

*Chapter 464, Public-Local Laws of 1913, page 981.

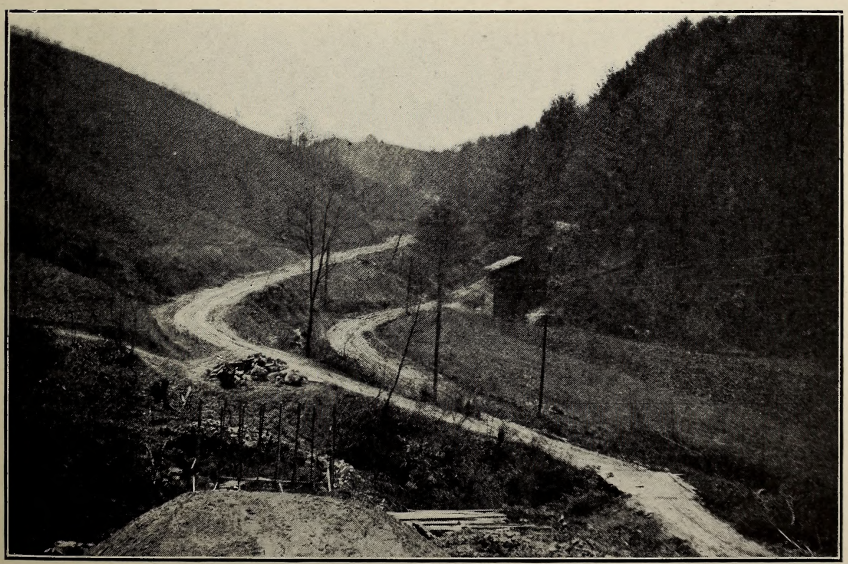
As directed in this act, the Highway Division of the North Carolina Geological and Economic Survey made a survey for the location of this road in Madison County. Forty convicts were detailed by the Council of State to construct this road, and they began work in September, 1913, at Walnut. From this camp the convicts constructed about three and one-quarter miles of road, and then as there was some question about the road commissioners being able to obtain a right of way for the route selected by the Highway Division of the North Carolina Geological and Economic Survey, the convicts were moved to a camp about one and one-half miles east of Wolf Creek Gap on the Tennessee line. From this camp the convicts have built about three and one-half miles of road towards Hot Springs. The camp was then moved to Hot Springs and they are now completing the link between Hot Springs and the road built from the second camp. This link was approximately three miles long, and they have about two miles more to construct. When this link is finished, the convicts will probably be moved to a camp near Marshall, to complete a link of about two and one-half to three miles connecting the Mars Hill and Walnut roads. When this is completed it will make between eleven and twelve miles that have been built by the convicts, leaving three to four miles yet to be constructed, according to the act.

Splendid results have been obtained in road construction by this camp of State convicts, and the cost per cubic yard of material removed during the work compares very favorably with the good results obtained on Hickory Nut Gap work. The road constructed will be a link in the Central Highway.

The work done by the State convicts in Madison County has been under the general supervision of the State Geologist and under the direct supervision of D. Tucker Brown of the Survey staff, and J. B. Clingman, one of the highway engineers of the Survey, who has been given leave of absence to become highway engineer for Madison County. In the construction of both the Hickory Nut Gap road and the Madison County road no grade over 4½ per cent has been made, and the width of the road has been maintained from twenty to twenty-four feet except for very short distances, where the road had to go through solid rock. As far as possible, permanent culverts have been put in, either of stone or metal. Plates III and IV illustrate the work done by the State convicts in Madison County.

The words "Plates III and IV" in next to last line above should read "Plate III A and B."

A. Central Highway, Madison County.
Built by State Convicts.



B. Central Highway, Madison County.
Built by State Convicts.

STATE CONVICTS ON PUBLIC ROADS.

At the special session of the General Assembly of 1913 the Highway Division of the Survey was called upon for additional work by an act relating to the work of State convicts on public roads. The act* as passed was as follows:

The General Assembly of North Carolina do enact:

Plans furnished or approved by geological survey preliminary to application.

SECTION 1. That any county or township or good roads district that desires to use convict labor in the construction or improvement of its highways shall apply first to the Geological and Economic Survey to lay out and make plans for said work or to approve plans already made.

Application for convicts.

SEC. 2. That the said county, township, or good roads district shall then apply to the board of State Prison directors for the number of convicts desired for the work, this number in no case to be less than forty.

Minimum number.

Directors to furnish convicts.

SEC. 3. That the board of directors, as soon as possible after the receipt of the application and the approval of the Council of State, shall furnish the labor requested, and proceed to construct or improve the highway under the direction of the State Geological and Economic Survey.

Applications honored in turn.

SEC. 4. That all applications from counties, townships, or good roads districts for convict labor shall be honored in turn, according to the date of their receipt, except that no county, township, or good roads district may use at any time more than one hundred convicts if an application from another county is pending and no labor is available for it.

Maximum of convicts furnished.

Hire of convicts.

SEC. 5. That counties, townships, or good roads districts using convict labor shall pay to the State therefor the sum of not less than one dollar per day for each laborer, shall furnish quarters, to be approved by the board of prison directors, for prisoners and employees; shall also furnish pure drinking-water and necessary firewood for camp use, and shall furnish overseers to direct the work. All other expenses of every kind whatever shall be borne by the board of prison directors.

Quarters, water, fuel and overseers.

Expenses borne by prison.

Existing agreements not affected.

SEC. 6. That this act shall not interfere with or apply to the agreements now existing and in force between the authorized authorities of the State and the Elkin and Alleghany Railroad Company, the Statesville Air Line Railroad Company, the public road in Madison County, under chapter four hundred and sixty-four, Public-Local Laws of one thousand nine hundred and thirteen; the Watauga and Yadkin Valley Railroad Company, and the Hickory Nut Gap dirt road now being constructed by the State and leading across the Blue Ridge Mountains through the county of Henderson: *Provided*, that if said railroad companies shall at

Proviso: failure by railroad companies to vitiate contract.

*Chapter 37, Public Laws, Extra Session 1913, page 66.

any time have failed to carry out the provisions of the agreement existing between them and the authorities of the State of North Carolina, then the State shall be under no further obligation to furnish convict labor, and may at once withdraw such labor from the railroad company so using.

Reserve for farm.

SEC. 7. That the State farm or penitentiary authorities or Council of State shall at all times reserve a sufficient number of convicts to properly cultivate and conduct the State farm.

SEC. 8. That all laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 9. That this act shall be in force from and after its ratification.

Ratified this the 13th day of October, A. D. 1913.

The only convicts that have thus far been worked on the roads under this act are fifty that were detailed to Randolph County. The Highway Division of the Survey has been able to locate the road that the convicts were to work and has, from time to time, inspected the construction work that they have done.

SALISBURY AND RALEIGH HIGHWAY.

At the extra session of the General Assembly of 1913 an act was passed to provide for the construction and maintenance of the Salisbury and Raleigh Highway.* In this act it states:

"The Highway Division of the North Carolina Geological and Economic Survey is hereby charged with the duty of selecting and designating the route of the said highway and to report the route so selected and the roads so designated to the board of trustees hereinafter provided for, and shall also report to the boards of commissioners of each county through which the said highway shall pass the route or line of road designated through such county. The duties imposed by this act upon the Highway Division of the North Carolina Geological and Economic Survey shall be considered a part of its official duties without additional compensation."

It was not considered advisable by the Geological Board to undertake to locate this highway or report to the county commissioners of the several counties through which it would pass until said commissioners had signified that they were ready to take up the construction of said highway. Therefore, the only work that has been done has been in Randolph and Davidson counties, at the request of the trustees of those counties. The link of this highway from Denton, Davidson County, to Ashboro, Randolph County, was located, and this location reported to the commissioners of those two counties.

*Chapter 241, Extra Session 1913, page 297.

The Survey has been called upon to do a great deal of work in connection with the construction of special highways authorized by the General Assembly, and it has been instrumental in obtaining the revenue with which to construct the various links of these highways. In some instances it has assisted through committees and otherwise in raising money by private subscription and in other instances has assisted in the passage of bond issues in township or county.

SPECIAL HIGHWAYS.

The following highways, in addition to those authorized by special acts of the General Assembly, have received considerable assistance from the engineers of the Highway Division of the Survey:

CENTRAL HIGHWAY.

The Central Highway, extending from Beaufort harbor to the Tennessee line at Wolf Creek Gap, was authorized by the General Assembly of 1911.*

As directed in this act, the State Geologist has kept in close touch with the construction of each link of the highway and has encouraged its construction in every way possible. Various engineers of the Survey have assisted in the location of the road and the State Survey has been very greatly assisted in this work by engineers from the United States Office of Public Roads. The highway passes through nineteen counties. Many of these counties have entirely completed their link of the highway, while in others it is only partly completed. With few exceptions, all the counties have provided funds, either by counties or townships, for the construction of their portion of the highway. In the table below there is given the condition of the highway in each county, the amount built, character of road, and the amount remaining to be built.

Nearly all the highway has been inspected during the past year by the State Geologist. In July, 1913, a trip was made from Hickory, Catawba County, to Morehead City, Carteret County, by Mr. H. B. Varner, chairman of the board of trustees of the Central Highway; Mr. G. D. Canfield, of Morehead City, trustee for Carteret County, and the State Geologist. Mr. Canfield very kindly furnished the car for making this trip.

There is given in the following table an approximate statement regarding the Central Highway at the present time.

*Chapter 58, Public Laws 1911, page 195.

Table Showing Condition of Central Highway.

County.	Miles of Highway.	Amount Surveyed and Located.	Amount Graded.	Amount Surfaced.	State Engineering Assistance.	Private Subscription.	$50.00 County Appropriation.
Carteret	18	all	10	10	yes	all	no.
Craven	50	all	12	12	yes	----------	no.
Lenoir	27	all	12	12	yes	----------	no.
Wayne	19	all	15	10	yes	partly	no.
Johnston	28	22	22	15	yes	partly	no.
Wake	26	all	all	24	yes	partly	no.
Durham	20	all	all	all	no	----------	
Orange	31	all	all	all	yes	partly	no.
Alamance	25	all	all	22	yes	partly	no.
Guilford	28	all	all	all	no	----------	no.
Davidson	30	all	13	2	yes	----------	no.
Rowan	38	all	all	all	no	----------	no.
Iredell	19	all	all	all	yes	----------	no.
Catawba	23	all	20	20	yes	----------	no.
Burke	22	all	8	3	yes	----------	yes.
McDowell	22	all	8	3	yes	partly	
Buncombe	25	all	all	all	yes	----------	no.
Madison	26	all	20	10	yes	partly	no.

TRIANGULAR HIGHWAY.

The third link of the Triangular Highway, extending from Pinehurst to High Point, has been largely located by the engineers of the Survey; and considerable construction work has been supervised, also, by the Survey engineers.

The demands made on the funds of the Survey for these particular phases of road work have made it impossible for the Highway Division to render to the counties the engineering assistance that they have desired. The requests that are constantly being received for such assistance emphasize the need of a much larger appropriation to the Highway Division of the Survey for carrying on this work, or the creation of a State Highway Department.

ROAD MATERIALS EXAMINED AND TESTED.

One phase of the work of the Highway Division of the North Carolina Geological and Economic Survey has been investigations in certain counties of materials suitable for surfacing roads. These investigations have included examinations of clays and sands for sand-clay roads, various gravels for gravel roads, and stone for macadam roads.

The material that should be used in surfacing a road should be determined largely by the amount and character of traffic that is to pass over the road and the available materials. In some counties of the State one

road can be built at a moderate cost, while in other counties the cost of the same type of road would be excessive. On the other hand, one kind of road which would take care of the traffic in one county would not be the right surfacing material for the heavier traffic found in another county. In certain counties it is found advisable to build one type of road for a certain distance leading out of the cities, and then carry the road to the county line with a lighter surfacing material. This is economical and permits the county to construct a greater mileage of hard surfaced road than if it attempted to build all the roads of the same surfacing material required by the roads carrying heavier traffic near the cities. It is not economical to construct the roads near the centers of population with a lighter surfacing material than that demanded by the traffic, in order to give the same kind of surfacing to the roads all over the county. In illustrating this point, it might be said that the Highway Division is urging those counties that are attempting to build a system of water-bound macadam roads all over the county to refrain from this type of road and build a bituminous macadam road for certain distances out from the cities, and then a sand-clay or gravel road over the balance of the county. As traffic increases over those roads that have been surfaced with sand-clay or gravel, when the time comes when they demand the heavier surfacing material, it will be found that the county has increased sufficiently in wealth to enable it to resurface with the heavier materials, as bituminous macadam, without any additional tax on the people. On the other hand, if the roads have been properly located, this does not have to be changed, and the macadam is laid directly on the foundation already prepared, the people in the meantime having had the use of a hard surfaced road during these years.

Assistance, advice, and suggestions regarding the selection of road materials have been given to the following counties:

By the State Geologist to—
County commissioners of Durham County,
Road superintendent of New Hanover County,
Road commissioners of Madison County,
Hickory Nut Gap Road, Henderson County,
Chapel Hill Township, Orange County.

By R. P. Coble:
Highway commissioners of Forsyth County,
Davie County.

By J. B. Clingman:
Highway Commission of Sylva Township, Jackson County.

The Highway Division of the Survey has examined the following samples of road materials:

SAMPLE I. DUPLIN COUNTY.
Very fine-grained, loamy sand. Not suitable for surfacing road.

SAMPLE II. DUPLIN COUNTY.
Sand-clay mixture. This sample contains approximately 50 per cent of sand, the voids in which amount to 23 per cent. Thus it will be necessary to add approximately one and one-half loads of additional sand to each load of the mixture used. When used in this way, it ought to make a satisfactory surfacing material.

SAMPLE III. DUPLIN COUNTY.
Fine-grained, loamy sand. Will not give good results as surfacing material.

SAMPLE IV. CHEROKEE COUNTY.
Partially decomposed quartzite. This sample contains a small amount of clay and a good deal of fine sand. It could be used in a sand-clay road by the addition of a small amount of clay.

SAMPLE V. DAVIDSON COUNTY.
Rhyolite.

At the present time the Highway Division of the Survey has no facilities for making physical tests of rocks as to their suitability as road materials in construction of water-bound or bituminous macadam, and such tests have been made for the Highway Division and for individuals in the State by the United States Office of Public Roads. The State department is able to make tests on clays, sands, and gravels as to their suitability for use as road surfacing materials, and also to examine mineralogically and chemically various rocks.

During the past two years the Office of Public Roads has examined eighteen samples, as follows:

No. 7771. ALAMANCE COUNTY.
Altered gabbro. This is a dark green, coarse-grained rock, composed essentially of plagioclase (labradorite), epidote, and chlorite.
It is a rock of low toughness, possessing a low resistance to wear and a fair cementing value.
It is recommended for use in macadam construction subject to medium traffic.

No. 8133. BUNCOMBE COUNTY. *Property of Theodore F. Davidson.*
Granite. This is a light gray, medium-grained granite, composed essentially of orthoclase, quartz, plagioclase (oligoclase), and biotite.

It is not recommended for plain macadam construction, except in the foundation course. It may prove satisfactory when used with an artificial binder.

No. 8134. Buncombe County. *Property of W. T. Weaver.*

Aplitic granite. This specimen is a light gray, fine-grained granitic rock, composed essentially of orthoclase, quartz, and muscovite.

This rock is not recommended for plain macadam construction, except in the foundation course.

It may prove satisfactory when used with an artificial binder.

No. 8135. Buncombe County. *Property of George S. Powell.*

Biotite gneiss. This rock is a dark gray, coarse-grained gneissoid rock, composed essentially of biotite, plagioclase (oligoclase), and quartz.

This material is not suitable for macadam road construction, except possibly for the foundation course.

It may prove satisfactory when used with a bitumen binder.

No. 7022. Cherokee County. *Property of Regal Marble Company.*

Metamorphic rock—marble. This is a rather soft rock, showing average resistance to wear, very low toughness, and good cementing value.

It should only be used on roads subjected to very light traffic.

No. 8169. Cherokee County.

Sand-clay gravel. This sample consisted essentially of large angular fragments of sandstone, with a large amount of quartz, sand, and clay.

It is not recommended for use in ordinary gravel road construction. Might be made fairly suitable for sand-clay construction, with the addition of 20 to 30 per cent of clay.

No. 8095. Davie County.

Disintegrated granite, consisting of angular grains of quartz and kaolinized feldspar and flakes of biotite and muscovite.

Should prove satisfactory for use in sand-clay construction in the natural state.

No. 7775. Davidson County. *Quarry of Paul & Cornell Company.*

Rhyolite. This is a light gray, porphyritic rock, composed essentially of large crystals of kaolinized orthoclase and plagioclase (oligoclase), embedded in a fine-grained crown mass of orthoclase, quartz, and chloritized biotite.

This material is recommended for use in water-bound macadam construction when subjected to heavy traffic.

Might also be satisfactorily used in connection with a heavy bituminous binder.

No. 7561. Forsyth County.

Granite. This is a light gray, medium-grained rock, composed essentially of orthoclase, quartz, microcline, muscovite, and biotite.

This is a hard rock, showing low toughness and resistance to wear, and fair cementing value.

Only recommended for the foundation course in macadam road construction, unless used with a bituminous binder.

No. 6793. JACKSON COUNTY. *Property of High Bryson.*

Metamorphic rock—biotite schist. This is a fine-grained, dark gray schistose rock, composed essentially of quartz, biotite, orthoclase, and muscovite.

This material is of variable hardness, ranging from average to very soft, low resistance to wear, low toughness, and good cementing value.

Only suitable for the foundation course in macadam road construction, unless used with bituminous binder.

No. 6794. JACKSON COUNTY. *Property of W. O. Allen.*

Metamorphic rock—biotite gneiss. This is a hard rock, showing average resistance to wear, low toughness, and fair cementing value.

Only suitable for the foundation course in macadam road construction, unless used with a bituminous binder.

No. 6795. JACKSON COUNTY. *Property of J. B. Ersley.*

Metamorphic rock—biotite gneiss. This is a medium-grained gneissoid rock, composed essentially of quartz, biotite, and orthoclase.

It is a hard rock, showing low toughness and resistance to wear, and good cementing value.

Only suitable for the foundation course in macadam road construction, unless used with a bituminous binder.

No. 6882. MACON COUNTY. *Property of J. G. Siler.*

Biotite gneiss. This is a dark gray, coarse-grained gneissoid rock, composed essentially of kaolinized orthoclase, quartz, biotite, and garnet.

This is a hard rock, showing low resistance to wear and toughness, and good cementing value.

In spite of the good cementing value shown in the testing, experience has shown that rocks of this type do not as a rule bind well on the road, and this material should, therefore, only be used in the foundation course in plain macadam construction.

No. 6883. MACON COUNTY. *Property of W. W. Allman.*

Biotite gneiss. This is a light gray, coarse-grained gneissoid rock, composed essentially of orthoclase, biotite, sillimanite, and garnet.

It is a very soft rock, showing very low resistance to wear, low toughness, and fair cementing value.

It is not recommended as a road building material.

No. 6884. MACON COUNTY. *Property of T. S. Waldroop.*

Biotite gneiss. This is a light gray, medium-grained gneiss, composed essentially of quartz and orthoclase.

It is a fairly hard rock, showing average resistance to wear, low toughness, and low cementing value.

Could be satisfactory for use in the foundation course in plain macadam construction or for use with a bituminous binder.

No. 7560. ROWAN COUNTY.

Hypersthene gabbro. This is a coarse-grained, dark gray rock, composed essentially of plagioclase (labradorite), augite, hornblende, and hypersthene.

This is a very hard rock, showing low toughness, average resistance to wear, and low cementing value.

Only recommended for the foundation course in macadam road construction, unless used with a bituminous binder.

No. 7618. STANLY COUNTY.

Portland cement.

No. 6900-A. VANCE COUNTY. *Quarry at Middleburg.*

Granite gneiss. This is a light gray, coarse-grained gneissoid rock, composed essentially of orthoclase, microcline, quartz, plagioclase (oligoclase), and biotite.

It is a hard rock, showing average resistance to wear, low toughness, and fair cementing value.

It is doubtful if this material would be suitable for bituminous macadam construction. It should, however, give satisfactory results in the finished course in plain macadam roads.

No. 7589. YANCEY COUNTY.

Biotite schist. This is a dark gray, medium-grained schistose rock, composed essentially of biotite, quartz, and orthoclase.

This is a hard rock, with low toughness and good cementing value.

Recommended for the finished course in macadam road construction only.

ROAD EXHIBITS.

Realizing that the industrial development of North Carolina was largely dependent upon the construction of good roads throughout the State, and that the prosperity of a State and its progressiveness are also largely dependent upon its mileage of good roads, and that one of the best advertisements of a State are good public roads, the Highway Division of the Survey has, during the past two years, made several road exhibits. The exhibits have consisted of photographs, illustrating the character of roads built throughout the various counties; maps and charts, showing the location of the various highways and their connection with the highways of adjoining States; samples of road materials such as were used in the construction of the roads; and publications descriptive of the roads and the country through which they passed. Such exhibits were made at:

Morehead City, July 31 and August 1, 1913, at the annual meeting of the North Carolina Good Roads Association.

Detroit, Michigan, September 29 to October 4, 1913, at the Third American Road Congress, held by the American Road Builders' Association.

Asheville, North Carolina, October 22 and 23, 1913, at a good roads convention held by the Southern Appalachian Good Roads Association.

Philadelphia, Pennsylvania, December 9, 10, 11, 12, 1913, in connection with the Road Congress held by the American Road Builders' Association.

Durham, North Carolina, July 9 and 10, 1914, at a convention held by the North Carolina Good Roads Association.

Bristol, Virginia, October 6, 7, 8, and 9, 1914, at a convention held by the Southern Appalachian Good Roads Association.

Atlanta, Georgia, November 9 and 10, 1914, at the Fourth American Road Congress.

At the National road congresses there were in attendance from three to five thousand people at each congress. There is no question but that these exhibits have given the State a wide advertisement in regard to its road situation, and has demonstrated to those interested that at the present time North Carolina probably stands first amongst the Southern States in regard to good public roads.

Similar exhibits have been made at:

The Central Carolina Fair, held at Greensboro, N. C., October 14-17, 1913;

The State Fair, held at Raleigh, N. C., October 21-24, 1913;

The Charlotte Fair, held at Charlotte, N. C., October 28-31, 1913;

The State Fair, held at Raleigh, N. C., October 19-24, 1914.

GOOD ROAD DAYS.

On September 27, 1913, Governor Locke Craig issued a proclamation, designating November 5 and 6, 1913, as Good Road days for North Carolina, and called on the State Geologist to assist in organizing the State, so that effective work could be accomplished on these two days. This entailed a great deal of extra work on the Survey, but the results which were accomplished on these two days were much greater than any one had expected and amply repaid the department for the work done. The work that was done on these two days has been published by the Survey in Economic Paper 35, entitled "Good Road Days."

COÖPERATION OF UNITED STATES OFFICE OF PUBLIC ROADS.

During the past two years the United States Office of Public Roads has been very liberal in coöperating with the Highway Division of the State Survey, and the work done has been of very great value to the cause of good roads in this State. The work has been along several lines similar to the State work.

EDUCATIONAL WORK.

Representatives of the Office of Public Roads have given lectures on good roads at the following places in North Carolina:

December 1, 1912, to November 30, 1914—List of Addresses.

No.	Place.	Lecturer.	Attendance.	Date.
				1913.
1	Washington	R. E. Toms	300	Jan. 27.
1	Newsom	H. B. Varner	250	Mar. 24.
1	Bain	H. B. Varner	25	Mar. 25.
1	Jackson Hill	H. B. Varner	35	Mar. 26.
1	Little Rock Creek	H. B. Varner	40	Mar. 27.
1	Healing Springs	H. B. Varner	20	Mar. 28.
1	Silver Hill	H. B. Varner	25	Mar. 29.
1	Southmont	H. B. Varner	35	Mar. 29.
1	Cedar Springs	H. B. Varner	20	Mar. 31.
1	Lexington	H. B. Varner	500	April 1.
1	Enterprise	H. B. Varner	75	April 2.
1	Ebenezer	H. B. Varner	20	April 3.
1	Wallburg	H. B. Varner	40	April 4.
1	Tyro	H. B. Varner	100	April 5.
1	Churchland	H. B. Varner	400	April 7.
1	Mill Knob	H. B. Varner	20	April 8.
1	Fair Grove	H. B. Varner	25	April 9.
1	Holly Grove	H. B. Varner	100	April 10.
1	Hedricks Grove	H. B. Varner	20	April 11.
12	Thomasville	H. B. Varner	1,000	April 12.
1	Henry's	H. B. Varner	30	April 14.
1	Yarbrough School	H. B. Varner	25	April 15.
1	Dentons	H. B. Varner	250	April 16.
1	Kindleys	H. B. Varner	40	April 17.
1	Reeds	H. B. Varner	60	April 18.
1	Yadkin College	H. B. Varner	125	April 19.
1	Arcadia	H. B. Varner	150	April 21.
1	Advance	H. B. Varner	100	May 23.
1	Mocksville	H. B. Varner	150	May 24.
1	Farmington	H. B. Varner	150	May 26.
1	Cooleemee	H. B. Varner	175	May 27.
1	Augusta	H. B. Varner	80	May 28.
1	Smith Grove	H. B. Varner	200	May 29.
1	Jericho	H. B. Varner	50	May 30.
1	Conetoe	H. B. Varner	200	July 5.
1	Waynesville	H. B. Varner	400	July 25.
1	Morehead City	W. L. Spoon	500	July 31.
1	Denton	H. B. Varner	200	Sept. 8.
1	Jackson	W. L. Spoon	1,500	Sept. 24.
1	Gilreath	H. B. Varner	75	Oct. 11.

List of Addresses—Continued.

No.	Place.	Lecturer.	Attendance.	Date.
				1913.
1	Chapel Hill	W. L. Spoon	800	Oct. 25.
1	Charlotte	W. L. Spoon	25	Oct. 26.
1	Enfield	H. B. Varner	500	Oct. 15.
1	Chapel Hill	L. E. Boykin	250	Nov. 5.
1	Smithfield	H. B. Varner	400	Nov. 7.
				1914.
3	Roxboro	W. L. Spoon	100	May 9-10-11.
1	Leesville	W. L. Spoon	700	May 7.
1	Chapel Hill	C. S. Reeve	50	Mar. 18.
1	Rocky Mount	W. L. Spoon	150	Jan. 26.
1	Hassell	D. H. Winslow	250	July 7.
1	Durham	D. H. Winslow	276	July 10.
1	Oxford	D. H. Winslow	90	Aug. 18.
1	Raleigh	D. H. Winslow	90	Aug. 27.
1	Elizabeth City	D. H. Winslow	400	Sept. 10.
1	Stem	D. H. Winslow	150	Sept. 29.
1	Chapel Hill	D. H. Winslow	200	Oct. 16.
1	Oxford	D. H. Winslow	80	Nov. 4.
1	Oxford	D. H. Winslow	345	Nov. 12.

ENGINEERING ASSISTANCE.

Construction of Object-lesson Roads.

Engineers from the Office of Public Roads have supervised the construction of object-lesson roads in several counties. Some of the roads constructed have been macadam, others sand-clay, and others earth roads. Some of this work was done during 1912, but no description of the work has been given until this report.

Macadam Roads.

Jerusalem, N. C.—Surfacing was started on a road leading from Jerusalem southeast toward South Yadkin River on October 15, 1912, and completed on December 2, 1912. The road had been graded before the arrival of the representative of the Office of Public Roads, and no data concerning the cost of grading could be obtained. The land adjacent to the road is rolling, and the soil is sandy loam from station 0.00 to station 13.00 and red clay from station 13.00 to station 20.00. The macadam surface is 2,210 feet long and 12 feet wide, making a total area of 2,950 square yards. The stone consisted of coarse-grained light granite for the foundation course and trap or field stone for the wearing surface. The compacted depth of the foundation course was 3¾ inches, and of the top course, including the screenings, 2¼ inches. Surfacing material to the amount of 655 cubic yards was used, and of this 364 cubic yards was purchased.

Concrete gutters 1 foot wide, 3 inches thick, and dished from 1 inch to 2 inches, were constructed on each side of the road throughout its length. Cross drains 14 feet long, of bell-joint pipe, were constructed at stations 3.00, 5.50, 10.75, 13.00, and 18.50. The diameter of the first four drains was 4 inches and of the last 6 inches. The ditches for the cross drains in each case were filled with broken stone. Underdrains of 6-inch bell-joint pipe 12 feet, 33 feet, 40 feet, and 16 feet long were constructed at stations 3.00, 5.50, 10.75, and 13,00, respectively. Concrete drop inlets 10 inches square and 2 feet deep, having 3-inch walls, were provided for these drains. Three hundred and seventy-four sacks of cement were used in constructing the gutters and drop inlets.

The equipment consisted of a crusher having an average capacity of 50 cubic yards per 10-hour day, a 10-ton roller, a sprinkling cart, and slat-bottom road wagons. The crusher and roller were both borrowed, and the only cost in connection with their use was the operating and maintenance expenses. The average haul from quarry to crusher was one-half mile and from crusher to road 500 feet. The water for the crusher, roller, and sprinkler was pumped.

The total cost of surfacing the road was $2,073.07, and the rate per square yard $0.703. Labor cost $1.40 per day, teams $3 per day, and fuel $6 per ton. The principal items of cost were: Materials for concrete gutters and drop inlets, $192.30; labor for these gutters and inlets, $120.05; drain pipe, $17.16; labor for the drain pipe, $7.07; surfacing material, $273; quarrying, $243.54; hauling to the crusher, $251.52; crushing, $136.38; hauling from the crusher to the road, $153.45; spreading, $140.17; sprinkling, $13.50; rolling, $13.13; hire of the sprinkler, $25; explosives, $99.50; crusher repairs, $25; drill steel, $28.40; sharpening the drill steel, $16.40; fuel, $62.10; lubricating oil, $12.50; loosening old macadam, $16.80; screening, $2.80; clearing, $25.90; and general expenses, $197.40.

Monroe, N. C.—A macadam road leading southeast from Monroe toward Wingate, known as the Lee Mill Road, was started on October 12, 1912, and completed on November 22, 1912, and during this time 3⅓ days were lost on account of unfavorable weather. This road had been graded before the arrival of the office representative, and no data relative to the cost of grading were available. The grade varies from a maximum of 3 per cent to level. The adjacent land varies from rolling to hilly, and the soil is red clay and clay shale. Local sandstone was used for surfacing. This stone possesses good wearing qualities, but poor binding qualities, making it a good material for the foundation course, but not well suited for the top course.

The total length surfaced was 2,510 feet and the width 10 feet, giving a surfaced area of 2,789 square yards. The stone was laid in three courses—the bottom course consisting of stone varying in size from 1¾ inches to 4 inches, the second course from 1 inch to 1¾ inches, and the top course from dust to 1 inch. The total compacted depth of the surface was from 7½ inches to 9 inches. The crown of the finished roadway was three-fourths inch to 1 foot. Stone to the amount of 1,133 cubic yards was crushed, but only 997 cubic yards was used. The stone was hauled from the quarry to the crusher for an average distance of 175 feet in wheelbarrows, and from the crusher to the road for an average distance of 2,000 feet in slat-bottom wagons, with a capacity of approximately one cubic yard. The stone was loaded directly from the bins into the wagons. Water for the crusher engine was carried 200 feet by hand, and hauled 300 feet for the roller. Four tons of fuel were used at the crusher and 5½ tons by the roller.

The equipment consisted of a stone crusher having 73 cubic yards capacity per 9-hour day, an engine, a 10-ton roller, slat-bottom wagons, and hand tools. Convict labor and teams owned by the county were used. The cost to the county per day per convict and per mule was $0.45. The total cost of the road was $647.15, making a rate of $0.232 per square yard.

The principal items of cost were: Preparing the subgrade, $22.95; quarrying, $117.45; hauling to the crusher, $66.60; crushing, $50.40; hauling from the crusher to the road, $112.94; spreading the stone, $22.95; sprinkling, $8.11; rolling, $68.95; stacking and loading screenings, $31.05; shaping shoulders, $11.70; loss of time due to bad weather, $57.35; and incidental expenses, $76.70.

North Wilkesboro, N. C.—Work was begun on a macadam road leading from North Wilkesboro toward Wilkesboro on October 2, 1912, and was discontinued on December 21, 1912. Thirteen and one-half days were lost on account of bad weather. A section of road 800 feet in length was entirely completed and an additional length of 494 feet was partially completed. The section completed follows the Yadkin River, and the entire road is subject to overflow at flood seasons. To remedy this condition the grade of the road was raised and the macadam was laid on a Telford base.

The natural soil is clay and silt and the adjacent land is level. There was no cut, and the maximum fill was 3.9 feet and the average fill 2.1 feet. The maximum grade of 5.85 per cent was reduced to 2.5 per cent.

A total length of 1,294 feet was graded 30 feet wide. All the material for the embankment was taken from pits located at an average distance

of three-eighths mile from the road and in no case more than one-half mile. It was loosened with a plow, loaded with shovels on slat-bottom wagons, and spread by hand.

A subgrade 16 feet wide was prepared for a distance of 1,294 feet and a Telford base 12 inches thick was laid upon it for the same distance. A macadam surface was laid upon this base to the same width for a distance of 800 feet. The surface was laid in two courses, each 3 inches thick compacted, and each course was bonded with screenings. The stone used on the bottom course consisted of pieces from 1½ to 3 inches in size, and the stone used in the second course ranged from one-half inch to 1½ inches. The screenings consisted of material ranging from dust to particles one-half inch in size.

The Telford base and the macadam surface were both made from mica gneiss obtained from the same quarry. This material possesses excellent binding and wearing qualities. It was quarried at an average distance of 1½ miles from the road, crushed at the quarry, loaded into dump wagons by means of a chute from the bins, and hauled to the road, where it was spread with forks.

The following drainage structures were constructed: One reinforced concrete culvert 2 by 4 feet by 29 feet long; one reinforced concrete culvert 2 by 6 feet by 30 feet long; one reinforced concrete culvert 2 by 6 feet by 28.5 feet long; and one wooden-box culvert 2 by 3 feet at an intersecting road.

The equipment consisted of one stone crusher with a capacity of 25 cubic yards per day, elevator, bins, one 10-ton roller, six 1½ cubic yard dump wagons, slat-bottom wagons, one turn plow, and hand tools.

The labor cost for men was $0.12½, $0.13½, and $0.15 per hour, and double teams cost $0.30 per hour. The working day was 10 hours long.

The total cost of the road was $3,293.29, which is at the rate of $1.8875 per square yard. The principal items of cost were as follows: Excavation and embankment, 979 cubic yards, at $0.40 per cubic yard, $391.60; clearing and grubbing, 2,300.4 square yards, at $0.0017 per square yard, $4; shaping the subgrade, 2,300.4 square yards, at $0.06 per square yard, $139.58; Telford foundation, 2,300.4 square yards, at $0.489 per square yard, $1,124.01; quarrying and crushing the surfacing materials, 380 cubic yards, at $1.525 per cubic yard, $579.49; hauling the surfacing materials, 380 cubic yards, at $0.645 per cubic yard, $245.30; spreading the surfacing materials, 380 cubic yards, at $0.108 per cubic yard, $40.93; sprinkling and rolling, 1,422.2 square yards, at $0.15, $213.63; reinforced concrete drainage structures, $473; and general expenses, $40.63. The above costs do not include any charge for the use of the stone crusher, elevator, and bins.

Sand-clay Roads.

Calypso, N. C.—A section of road leading from Calypso southeast toward Kenansville was graded and surfaced between September 4 and September 14, 1912. The adjacent land is slightly rolling and the soil is sandy throughout the length of the section. The grading consisted in plowing the ditches and bringing the road to the proper cross-section with a road machine. A small amount of material was moved for an average distance of 50 feet with drag scrapers. For 1,650 feet the road was graded 24 feet wide and surfaced 14 feet wide, making the area graded 4,400 square yards and the area surfaced 2,563 square yards. The crown of the finished roadway was three-fourths inch to 1 foot. Clay to the amount of 248 cubic yards was hauled an average distance of 2,400 feet, and 55 cubic yards of sand was hauled an average distance of 1,760 feet. Farm wagons having an approximate capacity of 1 cubic yard were used for hauling both sand and clay. They were loaded and unloaded with shovels. Two corrugated-iron culverts were ordered for this work, but were not received before the surfacing was completed. Directions were furnished for placing them.

The equipment consisted of 1 road machine, 1 rooter plow, 1 turn plow, 1 split-log drag, 2 drag scrapers, 1 disk harrow, farm wagons, and hand tools. Labor cost $1 and $1.50 per day and teams cost $1.20 and $2.50 per day. The total cost of the work was $133.60, which is at the rate of $0.0521 per square yard. The principal items of cost were: Grading and shaping the subgrade, $38.60; loading sand, $3.75; hauling sand, $6.25; spreading sand, $1.50; loading clay, $22.65; hauling clay, $49.25; spreading clay, $5.50; mixing clay and sand, $4.80; and final shaping with a drag, $1.60.

Jerusalem, N. C.—A sand-clay road running from Cooleemee northeast to Jerusalem was begun on September 3, 1912, and completed on October 18, 1912. The land adjacent to the road is rolling and the soil varies from "black-jack" gravel to micaceous clay. This road had been graded to a width of 24 feet in cuts and 18 feet in fills, and the drainage structures were all completed before the object-lesson work was begun.

The sand for use in surfacing was loosened with plows, loaded with hand shovels, hauled approximately 1¼ miles in slat-bottom wagons, and spread with grader and by hand. The subgrade prepared for surfacing was 20,020 feet long and 16 feet wide, making a total area of 35,590 square yards. The same area was given a sand-clay surface 6 inches thick after compacting, with a crown of three-fourths of an inch

to 1 foot. For the surfacing 4,820 cubic yards of material was used, approximately 3,000 cubic yards of which had to be purchased. The cost of labor was $1.25 per day, and of teams $3 per day.

The cost of the work was $1,799.61, which is at the rate of $0.0506 per square yard. The principal items of cost were: Loading sand, at $0.0605 per cubic yard, $291.61; mixing surfacing materials, at $0.001 per square yard, $37.25; shaping, at $0.0015 per square yard, $53.25; spreading sand, at $0.0137 per cubic yard, $66; hauling sand, at $0.2546 per cubic yard, $1,227; purchase of sand pits, $105.25; and general expenses, including water boy, etc., $19.25. The cost of superintendence, which is included above, was 6.32 per cent of the total cost.

Lexington, N. C.—A sand-clay surface was constructed at Lexington on Fifth Avenue south from Center Street, toward the southbound railroad station. The work was begun on July 22, 1912, and was completed on August 22, 1912. The adjacent land is rolling and the natural soil is clay of a plastic nature, but lacking in toughness.

The first work was grading. The earth was loosened by means of a traction engine and a road plow, loaded and hauled with drag scrapers, wheel scrapers, and wagons, and spread with shovels. The maximum cut was 4 feet and the maximum fill 3 feet. The maximum grade was reduced from 3 per cent to 1 per cent.

The equipment consisted of three No. 2 wheel scrapers, six No. 2 drag scrapers, two plows, three 1½-cubic-yard dump wagons, one 12-horsepower traction engine, picks, shovels, etc. The average haul for excavation was 150 feet and the maximum haul 400 feet. The sand mixed with the clay for surfacing was obtained from a pit and hauled for an average distance of 3 miles in 1-cubic-yard slat-bottom wagons. The quality of the sand was excellent for the purpose for which it was used. Free labor cost $1.25 and $1.50, and foreman $3 per 10-hour day. Convict labor was estimated at $1 per day, and teams cost from $2 to $3 per day.

The total length graded was 3,000 feet, and the width graded, both in cuts and fills, was 30 feet, making the total area graded 10,000 square yards. The entire length of 3,000 feet was surfaced for a width of 18 feet, making the area surfaced 6,000 square yards. The compacted depth of surfacing material was 4 inches and the crown three-fourths of an inch to 1 foot. The earth excavation amounted to 3,975 cubic yards, and the sand used for surfacing amounted to 815 cubic yards. The total cost of the work was $1,177.45, which is at the rate of $0.196 per square yard of surfaced area. The principal items of cost were: Excavation, 3,975 cubic yards, at 11 cents per cubic yard, $440.35; hauling 815 cubic yards

of sand, at 80 cents per cubic yard, $652; spreading 815 cubic yards, at $0.016 per cubic yard, $12.75; mixing the sand and clay, $60.60; sprinkling, $6; and general expenses, $5.75.

Earth Roads.

Calypso, N. C.—On September 16 and 17, 1912, a representative of the Office of Public Roads who had supervised the construction of an object-lesson sand-clay road at Calypso, assisted the local road officials in getting work under way on an earth road. During these two days a section of road 800 feet long was partially cleared and graded, though no part of this was entirely finished.

Twenty-one dollars and twenty cents was spent for this work, of which $6 was spent for clearing and grubbing and $15.20 for grading. Instructions were given by the office representative for continuing the work.

During the fiscal year of the Office of Public Roads of 1913-14 there were ten object-lesson experimental roads constructed in North Carolina by the Federal office. Also during this time engineers were assigned to make inspection of roads and advise with local officials in fourteen localities.

BRIDGE WORK.

The State Survey has also been very materially assisted by the United States Office of Public Roads in regard to the designing and construction of highway bridges and culverts. Typical designs for I-beam bridges with wooden floors for spans from twelve feet to forty feet were furnished for twelve bridges used in this State.

The Office of Public Roads also made four bridge inspections, advising with the local officials concerning the most practical type of bridge to build.

In addition to the work mentioned above, the Office of Public Roads assigned engineers who visited six counties, making special inspections and giving advice to local officials on various phases of road work.

This office has also made the surveys and prepared plans and specifications for the post roads in Davie, Forsyth, Iredell, and McDowell counties, which are being constructed under the supervision of engineers of the United States Office of Public Roads.

In connection with the plan organized by the Office of Public Roads to detail engineers to have charge of the maintenance of a highway extending from Washington to Atlanta, provided the counties through which the highway would pass would donate a certain amount per mile of road within their borders, the counties of Cumberland, Durham,

Granville, Harnett, Jackson, Moore, Richmond, and Wake have appropriated the necessary funds.

The maintenance of this highway through these counties is under the charge of engineers from the United States Office of Public Roads.

The highway has been divided into sections and a supervisor has charge of each section. It has demonstrated very conclusively that roads can be maintained if the work is taken up systematically, and it also emphasizes that it will be done in this way when the work is in charge and supervised by a competent engineer. It illustrates very emphatically the need of a State Highway Commission which would be able to take up with the rest of the counties in the State similar work.

COÖPERATION WITH NORTH CAROLINA GOOD ROADS ASSOCIATION.

During the past two years the State Survey has assisted in every way possible the work of the North Carolina Good Roads Association and the Southern Appalachian Good Roads Association, and has assisted in planning for and carrying through two Good Roads Conventions for each of these associations.

The State Association meetings were held at Morehead City, Beaufort County, July 31 and August 1, 1913, and Durham, Durham County, July 9 and 10, 1914.

The conventions of the Southern Appalachian Good Roads Association were held at Asheville October 22 and 23, 1913, and at Bristol, Virginia-Tennessee, October 8-10, 1914.

By being identified with the work of these associations, the State Survey has been able to accomplish a great deal more in its road work throughout the State than otherwise could have been done. While it has undoubtedly been of very great assistance to these organizations, these, especially the State Association, have made it possible for the State to give engineering assistance to certain of the counties and townships that it otherwise could not have done.

In the latter part of 1913 the State Association federated with the National Highways Association and is known as the North Carolina Division of the National Highway Association. The State work is entirely separate and independent of the National Association, but through the coöperation of the National Association the State Association was able to employ a highway engineer and organizer who has divided his time between the association work and the work of the Survey, each paying their proportional part of his salary and expenses.

STATISTICS REGARDING ROAD WORK.

In order to arrive at some definite conclusions as to the status of the road work in the State and to keep in close touch with it, the Survey has tried to keep in communication with all the road officials of the State and collect statistics regarding the amount and kind of road constructed each year, how it is maintained, and how the revenue is obtained for carrying on the road work. These statistics have been published annually as a report on the road work in North Carolina for the previous year. The data collected show that we now have in North Carolina 48,991 miles of public road, of which there are 1,278¾ miles of macadam, 3,080 miles of sand-clay, 1,010 miles of gravel, and 106 miles of specially surfaced road; making a total of 5,474 miles of improved road in the State. Of this improved surfaced road, 1,015 miles were built during 1913 and 825 miles of dirt road were graded. There was raised by special tax for road purposes during 1913-14, either by township or county tax, $3,000,000. During 1913 and a portion of 1914 nineteen counties and forty-five townships voted $4,865,000 in bonds for road purposes.

BOND ISSUES FOR ROAD CONSTRUCTION.

A great many acts were passed by the General Assembly of 1913 relating to the construction of public roads in various counties and townships by means of bond issues or special tax. There is a great lack of uniformity in these bills and variations of the method of issuing the bonds, some issues being authorized by election on a certain date, some by election on petition to county commissioners, others to be directly issued by the county commissioners without any vote or petition, and still others to be issued upon the discretion of the county commissioners. In some cases the election would be carried if the majority of the votes cast were in favor of bonds; in others, if the majority of qualified voters cast their votes in favor of the bonds. Some of the acts called for special road or highway commissioners to take charge of the road work, and others placed the work under the county or township commissioners. Some provided definitely for a sinking fund with which to take care of the bonds when they mature, while others did not mention this. Some mention the question of maintenance and others make no reference to it.

When we stop to consider that the General Assembly is authorizing a county to issue bonds with which to build roads and sometimes instructing them to do this, it should be the function of the General Assembly to make the bond issue conditional upon the county or township definitely providing not only for the interest on the bond, but also pro-

viding a sinking fund which shall not be used for any other purpose and which will be adequate to take care of the bonds at the time they become due, and also make it obligatory upon the county officials that they provide an adequate maintenance fund with which to take care of the roads after they are built, and that this fund can only be used for maintenance. It should also be insisted upon that the bond issue can only be used for construction work and not for repair or maintenance. If the General Assembly would insist upon these measures in regard to bond issues, there would be little or no bond money wasted, and a great part of the objection to raising the money by bond issue with which to build roads would be removed.

The amount of money authorized by the General Assembly of 1913 for special county road work aggregated a total of $6,315,000, and for special township work $2,762,500, making a total of $9,077,500.

In addition to this, the General Assembly authorized any township in any but four of the counties of the State to issue bonds not exceeding $50,000 upon vote of the people. This raises the total amount authorized to nearly $70,000,000 by the General Assembly of 1913. A wise expenditure of this money, if it all should become available, would bring North Carolina up to the forefront of the States of the Union in all branches of industrial development, influence, and wealth. This would mean a saving to the State of at least $10,000,000 per year which the State is now losing on account of bad roads.

The acts as passed, however, will not insure this; but if the recommendations suggested above are passed, it will insure the above.

If it is the function of the State to authorize bond issues for counties and townships, it is the duty of the State to safeguard these bond issues by making their issue and expenditure dependent upon the work being done under the supervision of competent road engineers, the county or township officials providing sufficient revenue with which to maintain the roads after they are built. This means that the State must be in a position to give engineering assistance to any and all counties desiring same.

SUGGESTED ROAD LEGISLATION.

Although there are several ways in which a State can assist its counties in road work, I believe that the greatest need at the present time is for the State to give engineering assistance to its counties. While many counties have provided themselves with competent road engineers who have the supervision of the location, construction, and maintenance of their public roads, the majority of the counties have not paid sufficient

attention to the need of the employment of such engineers. There is no question but what the county officials are beginning to realize more and more the need of such engineers, and there is no question but what if the State was in a position to furnish engineering assistance to the counties there would be but very few counties that would not avail themselves of such assistance and put all their road work, both construction and maintenance, under the supervision of competent engineers.

This work can best be accomplished by the creation of a State Highway Department, and it is earnestly recommended that the General Assembly of 1915 give serious consideration to this need and assist the counties by establishing a Highway Department, with adequate funds to enable it to give at least engineering assistance to the counties.

SUGGESTED LEGISLATION FOR ESTABLISHING A STATE HIGHWAY DEPARTMENT.

The General Assembly of North Carolina do enact:

SECTION 1. That a State Highway Commission is hereby established, whose duties it shall be to assist the counties in developing State and county systems of highways as set forth most specifically hereinafter.

SEC. 2. The State Highway Commission shall consist of the State Geologist, a professor of civil engineering of the University of North Carolina, and a professor of civil engineering of the North Carolina Agricultural and Mechanical College, said professors to be designated by the president of their respective institutions. The members of the commission shall be appointed and serve for four years and until their successors are appointed; the members of the commission shall, when employed in any manner required of them under this act, receive their actual expenses.

SEC. 3. The Governor shall fill all vacancies in the commission caused by death or otherwise, and he shall have the power to remove any member for due cause.

SEC. 4. The commission shall appoint a civil engineer well versed in the science of road building and maintenance, who shall be the State highway engineer, whose compensation shall be fixed by the State Highway Commission. The term of office of the State highway engineer shall be six years from the date of his appointment, unless removed from office for due cause by the highway commission.

Offices.

SEC. 5. The proper State authorities shall furnish and provide suitable offices for the State Highway Commission in the city of Raleigh, and shall provide it with the necessary office supplies, fixtures, and stationery.

Assistants, Clerks.

SEC. 6. The State Highway Commission may employ such assistants and clerks as in its opinion the needs of the State demand. The salaries paid such assistants and clerks shall be determined by the State Highway Commission.

Duties of the Highway Engineer.

SEC. 7. Upon the written request of the road officials of any county desiring to avail themselves of the services of the highway engineer on the terms of this act, for advice in regard to the improvement of any bridge, road, roads, or sections thereof, the highway engineer shall survey or have surveyed such bridge, road, roads, or sections of road, and shall prepare, or have prepared, such maps, profiles, plans and specifications as are necessary in his judgment to determine the cost of the proper improvement of such bridge, road, roads, or section of road; and these, together with the estimated cost, shall be presented to the board of county commissioners or other officials in authority, who made the request for such information, at their next regular meeting held after the completion of such surveys and estimates. If such bridge, road, roads, or section of road should thereafter be built by the county officials, it shall be constructed according to the plans and specifications as furnished by the highway engineer. In the event that the construction work on any such bridge, road, roads, or section of road is not started within three months after the highway engineer makes his report to the county officials, the county officials shall and are hereby directed to reimburse the State Highway Commission for the expense incurred by its office in obtaining the information furnished the county officials. Should, however, the construction be taken up at a later date, the highway engineer, when he takes charge of the actual construction, shall return said amount to the county officials. The highway engineer, or his duly authorized assistants, shall have entire charge of the location, construction, and maintenance of all roads, bridges, etc., constructed under this section. The State highway engineer shall keep an accurate record of all costs and expenditures of his office. He shall supply technical information regarding roads to any citizen or officer in the State, and shall, from time to time, publish for public use such information as will be generally useful for road improvements. Such publications and his biennial report to the Legislature shall be printed at the expense of the State, as other public documents.

State Highway System.

SEC. 8. The State highway engineer shall from time to time make surveys, prepare plans, profiles, specifications, and estimates of the cost of a system of highways connecting by the most direct and practicable route all the county-seats and principal cities of the State. He shall make a detailed report to the State Highway Commission of mileage and cost in each county. He shall state the type and class of road suitable for each section. He shall give the average number and class of teams which each section of road is at present accommodating, and the probable increase in traffic which would follow improvements as recommended by him. If in the event a county or township undertakes the improvement of any section or sections of the system of roads as recommended by the State highway engineer and approved by the State Highway Commission, the construction of such section or sections shall be along the route as surveyed by the State highway engineer, or his duly authorized assistants; and the improvement shall be of a class as recommended by the State highway engineer. The supervision of the construction of any section of this system shall be under the State highway engineer, and

if after the construction period the section of road built by any county is not properly maintained, the State Highway Commission shall and is hereby directed to supervise its maintenance and charge such maintenance cost to the county through which the road was constructed; and any county against which such a charge is made shall and is hereby directed to pay to the State Highway Commission the cost of such maintenance.

The preceding paragraphs relating to the maintenance of roads shall be applicable to all roads constructed under State supervision as provided for in section 6 of this act.

Location of Roads.

SEC. 9. In the location of roads provided for in sections 7 and 8 the highway engineer shall so locate them as to serve the needs of the people in the immediate section in so far as this would not conflict with such roads being links in the system of highways provided for in section 8 of this act.

Consultation and Assistance from Members of Commission.

SEC. 10. The State highway engineer may call into consultation, for any engineering problem confronting him, the State Highway Commission.

SEC. 11. The State Highway Commission shall call an open meeting to be held at the office of the county commissioners within each county of the State at least one day in each calendar year, for the purpose of affording instruction relative to matters pertaining to road and bridge construction, maintenance and repairs. Such meeting shall be conducted by the State highway engineer or one of his assistants designated for the purpose by the State highway engineer.

Upon receipt of the notice from the State Highway Commission the county commissioners shall call such meeting on the date set by the State Highway Commission, and shall be present themselves and notify the county engineer, the commissioners of each township and the superintendent of each road district within the county to be present at such meetings in person. Each of the county, township, and road district officials above mentioned shall be paid the regular per diem allowance, in the usual manner, for the actual time in attendance at such meetings.

The members of the commission when employed in any manner required of them under this act shall receive their actual expenses.

SEC. 12. That the sum of $50,000 annually, or so much thereof as may be necessary, is hereby appropriated out of any moneys in the treasury not otherwise appropriated for the purpose of carrying out the provisions of this act.

SEC. 13. That all laws and clauses of laws in conflict with the provisions of this act are hereby repealed.

SEC. 14. That this act shall be in force from and after its ratification.

RESOLUTIONS REGARDING STATE HIGHWAY COMMISSION.

In connection with the recommendation of a State Highway Department, it may be well to give here the resolutions regarding this subject which were unanimously adopted by the American Road Congress at Atlanta, November 12, 1914. The resolutions were as follows:

"Whereas the American Road Congress believes and has long urged all States to enact uniform road legislation; and

"Whereas experience has abundantly demonstrated that efficiency and economy are not obtained in the construction and upkeep of main roads except by the coöperation of the States through skilled departments;

"Whereas forty of the forty-eight States have enacted State and county legislation, Georgia, Indiana, North Carolina, South Carolina, Tennessee, Arkansas, Florida, and Texas being the exceptions; and

"Whereas Federal aid and coöperation is near at hand, and it is probable that States having no highway departments will be unable to participate in such aid: Therefore be it

"*Resolved,* That the American Road Congress in annual convention assembled in the city of Atlanta, embracing several thousand delegates representing every State, reaffirm its belief that State road departments and State aid are essential to secure efficiency and economy; and be it further

"*Resolved,* That copies of these resolutions be sent to the Governors of all States and to their various highway officials, and that they be urged to promptly commend such laws to the Legislatures in their respective States."

FORESTRY.

The forestry work carried on by the State Survey is of both educational and practical value, and it has obtained information regarding the condition of the forest areas of the State and the industries dependent upon timber for the raw product that demonstrates conclusively the need of the State's taking up a definite forest policy that will conserve and perpetuate the timber supply of the State.

The importance of the forests to North Carolina is strikingly shown by the fact that the forests and the industries dependent upon them produce material amounting in value to more than $35,000,000 per year and give employment to over 30,000 men. There are but few States in this country where the importance of the forests is relatively as great as in this State, where one-sixth of the entire wealth-producing capital is invested in forest lands or in industries directly dependent upon the products obtained from the forests. As a State we recognize that our furniture industry is absolutely dependent upon a permanent supply of hardwood; that the tanning industry, if it is to become a permanent one, as it should, is dependent upon a constant supply of tanning material, as hemlock and chestnut-oak bark; and that the paper industry, which also should be a permanent one, is dependent upon a constant supply of pulpwood. I believe that it is not only possible to make these industries permanent in North Carolina and to give them a constant supply of the various woods that they need, but also to enable those industries to develop to a still greater extent. To do this, it is necessary that our forests be conserved and perpetuated.

The forest area of North Carolina covers more than 19,000,000 acres, a very large part of which is steep, rough, or poor land unsuitable for farming purposes. There are also about 2,000,000 acres of waste land in the State which have been lumbered and burned or cleared and found unprofitable to cultivate on account of roughness or erosion, which should be reforested.

No care was taken in lumbering to preserve seed trees and make it possible for the land to reforest itself to the best advantage. In lumbering no plan was considered with the end in view of the forests reproducing themselves with varieties of trees as valuable as the ones removed or that they would maintain a density so that the soil might produce its full capacity, or of even protecting the timber that still remained. Such methods of lumbering have finally brought us to the place where there is probably more woody materials used or cut each year in North Carolina than the forests are replacing by the formation of new wood. Then again, each year the forests become less capable of producing what is required of them. Their area contracts, less valuable trees take the place of the more valuable varieties which are cut, the soil becomes more impoverished and less able to yield large returns, and the demand for woody materials gradually increases with the increase in population.

These existing conditions demand that some steps be taken immediately to conserve and perpetuate our forests. This conservation means for a great many of our citizens a profitable investment and, in some instances, as the reforestation of abandoned farm lands, it will mean a profitable investment on lands that are now not producing anything of value.

FOREST POLICY FOR NORTH CAROLINA.

Measures that should be undertaken by the State which would represent its forestry policy should be:

a. A State forest fire protective system.

b. State-owned and operated demonstration forests and experiment stations.

c. The encouragement of forest planting by the maintenance of one or more forest nurseries.

d. The modification of taxes on nonrevenue-producing forest land.

(A) STATE FIRE PREVENTION.

Protection of the forests from fire is a prerequisite for all other measures of improvement. It is by far the most necessary and important measure for the State to undertake, because the success of all others depends on this. Fire protection should not be left entirely to a State

organization, but the State must inevitably take the lead. The aim should be to prevent fires, not to wait until they are started and then extinguish them. It is cheaper in the long run and far more effective, because it is educative. An adequate system should include a State forest warden and district and township wardens and patrolmen; it should provide for lookouts, patrol during dry and dangerous weather; the summoning of necessary assistance to extinguish fires, the collection of information about the cause, extent, and damage of fires; the posting of public warning notices, and the enforcement of the forest fire laws. The laws, besides providing for such a system, should endeavor to prevent the setting of fires by railroads and other users of coal- and wood-burning engines, by hunters, campers, farmers, smokers, and others who contribute towards our large annual damage from forest fires. Such a system must be entirely free from party politics, the officers being appointed solely with the idea of securing efficiency and the wardens paid only for the work done, at a fair rate per day or hour.

As soon as such a system is in force the Federal Government is ready and anxious to coöperate with the State in fire protection in proportion to the amount of money expended by the State. Seventeen States are already receiving such Federal assistance in sums varying from $1,500 to $10,000 a year each. The coöperation of associations of landowners would also no doubt soon be secured. Thirty such associations in nine different States are now actively engaged in fire protection. Railroads and other corporations and individuals as well as the local governments of counties and townships can also be counted on to do their share when they realize that the State is in earnest in trying to prevent forest fires.

(B) STATE DEMONSTRATION FORESTS.

The State should secure suitable areas of land in each of the forest regions of the State on which to experiment as to the best species to grow and the best methods of handling the different types of forest; while at the same time demonstrating to the woodland owners of the respective regions the practice and results of approved forest management. Five such areas are recommended, one each in the following types: the spruce, the mountain hardwoods, the Piedmont hardwood and pine, the Coastal Plain pine, and the Banks sandhill type. The first and the last would perhaps be the most valuable as experimental areas, but as demonstration forests the other three would probably directly concern the greater number of our citizens. The people are naturally slow to adopt methods which have not been tried under their peculiar conditions, and there is no better way to encourage the practice of forestry than by showing on State land how it is done and why it pays.

(c) STATE FOREST NURSERY.

For utilizing abandoned fields, of which, it has been estimated, there are one million acres in this State, and for the protection of the watersheds supplying water to towns and cities, planting forest trees is a most valuable practice and should be encouraged in every legitimate way by the State. Planting is not generally recommended, however, in North Carolina for reforesting already existing areas of woodland or cut-over lands. Regeneration can be more easily and cheaply accomplished by natural means if proper methods of cutting, thinning, etc., be adopted. At present the State Geological and Economic Survey assists private owners by inspecting proposed areas and advising what and when to plant. There is, however, no commercial nursery in the South which can furnish at a moderate cost the kinds of young trees which should be planted. There seems to be no reason why State nurseries, operated in connection with demonstration forests and experiment stations, should not supply this demand as it develops under State leadership.

(d) JUST TAXATION.

The landowners, lumbermen, and experts all agree that unfair taxation is one of the principal reasons why private owners do not practice forestry. It is not fair or wise to tax young, immature timber, or even standing mature timber year after year at a high valuation when the owner is getting no returns from it. Forest *land* should be annually taxed at its value as a producer of revenue, while the *timber crop* on the land should be taxed only once, namely, when it is cut and marketed. In order also to stimulate the planting of forest trees on abandoned farm land the State might well remit all taxes on planted areas for a term of years, thus reducing materially the burden to the landowner of carrying such a long-time investment. Such reforms in taxation, which have heretofore been impracticable, because unconstitutional, would have been possible if the proposed constitutional amendment on taxation had been adopted.

The Survey has been undertaking to bring before the people of the State an adequate conception of the forestry problem and to demonstrate that a definite forest policy would be a profitable investment for the State. Investigations have been made regarding forest fires, their number, their cause, and the amount of damage done; an inventory by counties of the timber resources of the State; examination of forest lands and reports as to how they can be managed most economically and to the best advantage of the growing timber, and the feasibility of reforesting abandoned farm lands, and investigations relating to the reproduction of various trees.

Lectures and addresses have been made in many sections of the State relating to forestry problems.

The subjects investigated can be treated only briefly in this report, but they have been published in detail in the series of publications of the Survey.

PROTECTION OF FORESTS FROM FIRE.

Forest fires are the greatest menace to the perpetuation of our forests. One of the worst effects of the forest fires in eastern North Carolina has been the prevention of the reproduction of the long-leaf pine. Large areas that were once covered with this valuable tree and which should now be reproducing another growth of the same kind are instead covered with sand-oak or blackjack, which are practically valueless. The loss to the people of this section from the burnings of these pine lands, taken in the aggregate, is enormous, as, but for the burnings, thousands of acres which are now denuded of all merchantable trees would either be covered with mature forests or with thick growths of young trees.

In the counties in the middle part of the State fires have done considerable damage in killing down young growth, but as a general thing, except where there are large tracts of forest and country is poor, rugged, or thinly settled, the lands are not regularly burned, and the damage that has been done to old trees is much less than in other parts of the State. These occasional fires, however, kill much young growth that has been several years growing and keep the woods open in this way.

In the mountains, although there is a great deal of excellent hardwood timber, many of the trees which would otherwise be merchantable have been badly damaged by fire. The woods have been kept free from young growth by pasturage and frequent burnings. In places they are exceedingly open and there are no young trees at all to take the place of the old ones as they are removed.

One result of the indiscriminate lumbering and forest fires in the mountain region has been the almost total destruction of the poplar, walnut, cherry, and white pine. These trees all come up from seed, so that if the young growth is destroyed by forest fires and no seed trees are left in lumbering, it means the extermination of these species, unless reforestation is resorted to.

The long-leaf pine, which was formerly very abundant in the Coastal Plain region of North Carolina, has been entirely exterminated in certain sections, and the localities where it now grows have been reduced to a very small area. The lands formerly covered with beautiful forests of long-leaf pine are now covered by small scrub oak, sand-oak, or black-

jack oak, which are entirely valueless as timber trees. This failure of the long-leaf pine to reproduce itself is due almost entirely to the frequent fires which year after year in the winter and early spring have devastated the pine woods, killing the young pine seedlings. The long-leaf pine only seeds infrequently, a large seed crop growing about once in five to seven years. The seed are large and nutritious, and when they fall they are eaten in large quantities by hogs, squirrels, and fowls. Then again after the seed has sprouted and rooted, the seedling is of such slow growth that it is three or four years before it begins to form any appreciable stem, all of its energies being used in growing a deep tap-root. This tap-root is not at all resinous, but is juicy and nutritious, and is dug up and eaten by hogs even when the trees are five or six years old. Thus, even if an area escapes burning, practically all of the young trees are eaten by hogs in those sections where there are no stock laws.

That the long-leaf pine will reseed and reproduce itself, if given an opportunity, is well illustrated in New Hanover County, where the stock law has been in force for a good many years, and also some attempt has been made to prevent forest fires. In the vicinity of Winter Park on the road from Wilmington to Wrightsville is a good example of land that has been reseeded in long-leaf pine. All along the track of the electric car line, on land whose chief value at present is apparently in the production of timber, there were long-leaf pine seedlings from one year old up, scattered nearly universally through what was once a solid pine forest, but which years ago was logged off and only a few scattered trees left, which, however, have served for seed trees. This young growth was from one inch to eight or ten feet high and in some places dense enough to eventually form a good forest.

With adequate laws, properly enforced, it would be possible to reforest large areas in the Coastal Plain region of North Carolina in long-leaf pine.

The yellow poplar and tulip poplar of the mountain region have in some sections been entirely exterminated, probably because no seed trees were left. Trees like the long-leaf pine, poplar, oak, etc., come up from the seed and do not reproduce from the root or stump like the chestnut.

In order to determine the cause of forest fires, statistics have been collected for the past four years in regard to forest fires. Question blanks have been sent out at the beginning of the year to every county, making inquiry regarding the number of forest fires during the previous year, total area burned over, amount and value of timber destroyed, area and value of young growth destroyed, value of forest products and

improvements destroyed, their causes as far as known, and amount of damage done by the fires.

The reports obtained in this way show that North Carolina lost during the past two years approximately $700,000 per year as a result of forest fires, and that the principal causes were carelessness, fires started by hunters, by farmers in burning brush, and by sparks from railroad locomotives. At a comparatively small cost North Carolina could prevent a large percentage of these fires from being started and be able to extinguish a very large percentage of those started before they had done any great amount of damage. To do this, however, it is necessary that adequate legislation be passed in regard to protection of forests from fire.

The statistics regarding forest fires of 1912 were collected in 1913 and published as Economic Paper 33. Statistics regarding forest fires in 1913 were collected and published in 1914 as Economic Paper 37.

The conclusion arrived at is that in order to successfully control forest fires both organization and coöperation are essential. Organization must originate with and be maintained by the State, and the State must act first. As soon as an organization is started, full coöperation can be secured from the Federal Government under the Weeks Law. In States containing National forests, such as North Carolina, assistance can also be secured from the Forest Administration. Experience has shown that the coöperation of timberland owners and lumbermen, and then of the railroads and other corporations, will quickly follow the State's initiative. The State, however, *must* take the lead.

TIMBER SUPPLY OF NORTH CAROLINA.

In order to ascertain as closely as possible the timber supply of North Carolina, arrangements have been made with the United States Forest Service for making a systematic study of the forest conditions of North Carolina. This work was started in 1909 and has been continued through the past two years.

The agreement under which this coöperative work between the Federal and State departments has been continued in the past two years is as follows:

AGREEMENT BETWEEN UNITED STATES DEPARTMENT OF AGRICULTURE, FOREST SERVICE, AND NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

This agreement, made by and between the Secretary of Agriculture of the United States and the State of North Carolina by and through its Geological and Economic Survey, witnesseth:

That for and in consideration of the mutual promises herein contained and of the mutual benefits to be enjoyed hereunder, it is agreed as follows:

1. That the North Carolina Geological and Economic Survey and the Secretary of the United States Department of Agriculture shall make a field study of the forest resources and forest conditions of the State of North Carolina and shall collect data which can be used in preparing a report or reports covering the following subjects:

(*a*) A map of the State or a portion of the State showing the distribution of the forests.

(*b*) The percentage of forest land in each county, together with its comparative value for agriculture, for the production of timber, and as a protection for streams.

(*c*) The percentage and location of the principal forest types, together with the approximate stand of timber per acre of the different species.

(*d*) The percentage and location of second-growth pole stands, and the age where possible.

(*e*) Data for ascertaining the yield of even-aged second-growth stands, both (1) fully stocked and (2) thinned, of (*a*) sprout hardwoods; (*b*) seedling hardwoods; (*c*) and pine; and the most practicable methods of managing each in the different forest types.

(*f*) A study of the most practicable methods of managing the different forest types to produce as nearly as possible the special kinds and amount of timber required by the industries.

(*g*) A study of the various methods of lumbering to determine the changes, if any, which can be recommended to improve the condition of the forest and to prevent unnecessary waste.

(*h*) A study of the allied industries, such as farming, stock raising, and mining, in their relation to the forests, in order that the relative importance of each may be determined.

(*i*) The damage, costs, frequency, and effects of forest fires, with the object of working out some practical system of fire protection.

(*j*) The practicability of planting in forest trees the abandoned fields or other waste lands, with the object of preventing erosion and producing timber.

Said report shall be as complete as the available funds will permit, shall contain recommendations for private owners in the handling of their lands to maintain and improve the forests, and shall contain a recommendation for a State forest policy and a State forest law, if advisable.

2. That the study which is carried on under this agreement shall be planned and conducted jointly by duly authorized representatives of the Forest Service and the North Carolina Geological and Economic Survey, and shall be subject to the approval of the proper authorities in each case.

3. That during the progress of the field work, a brief report shall be made in duplicate at the end of every month by the officer in charge and submitted to the Forester and the State Geologist.

4. That neither the Forest Service nor the North Carolina Geological and Economic Survey shall publish any of the results of this work until the report of such results is approved by both the Secretary of the United States Department of Agriculture and the State Geologist of the North Carolina Geological and Economic Survey. After such approval, the State shall have prior right

to publish the results relating to general forest conditions in the State, and the Forest Service shall have prior right to publish results relating to the condition, value, and yield of second-growth stands; but in all such publications the fact shall be plainly stated that the results were obtained through coöperation with the North Carolina Geological and Economic Survey and the United States Department of Agriculture.

5. That the North Carolina Geological and Economic Survey and the Forest Service shall share equally the cost of carrying out this agreement on the following basis:

The North Carolina Geological and Economic Survey shall supply the service of its forester for such length of time as will require the expenditure of at least $600 for his salary and field expenses while so employed, and shall deposit with the Treasurer of the United States for this purpose not less than $600 nor more than $700 in monthly installments of not less than $200 each, beginning July 1, 1913, which shall be used for paying the salary and expenses of the representative of the Survey.

The Forest Service shall supply the service of some of its employees as assistants to the Forester of the North Carolina Geological and Economic Survey for a sufficient length of time to require an expenditure of an amount equal to that deposited by the North Carolina Geological and Economic Survey for salary and field expenses of such employees while acting as such assistants.

6. That no Member of or Delegate to Congress shall be admitted to any share or part of this agreement or to any benefit to arise thereupon. (Rev. Stat., 3741.)

This agreement shall become effective on the first day of June, 1913.

In witness whereof the said Survey has hereunto caused its name and seal to be affixed by its proper officer, on the 23d day of June, 1913, and the said Secretary has hereunto set his hand and affixed his official seal on the date below written.

JOSEPH HYDE PRATT,
State Geologist, North Carolina Geological and Economic Survey.

Signed and sealed by the Secretary of Agriculture, this 8th day of July, 1913.

T. W. GALLOWAY,
Assistant Secretary of Agriculture.

This investigation was begun in the western part of the State, and the counties that have thus far been examined are Cherokee, Clay, Macon, Graham, Swain, Jackson, Haywood, Transylvania, Henderson, Buncombe, Madison, Yancey, Mitchell, Avery, McDowell, Rutherford, Polk, Cleveland, Gaston, Lincoln, Catawba, Alexander, Caldwell, Watauga, Ashe, Alleghany, Wilkes, Surry, Yadkin, Iredell, Mecklenburg, Cabarrus, Rowan, Davidson, Davie, Forsyth, Stokes, Rockingham, Guilford, Randolph, Montgomery, Stanly, Caswell, Alamance, Chatham, Lee, Wake, Durham, Orange, Person, Granville, Vance, Warren, and Franklin.

This leaves only the following six counties to be examined to complete the examination of the mountain and Piedmont sections of the State: Moore, Montgomery, Stanly, Richmond, Anson, and Union. This work will be continued during the coming field season.

Press bulletins have been prepared regarding the timber resources of each county. The information contained in these bulletins relates, among other things, to:

(1) The percentage of forest lands in each county, together with its comparative value for agriculture, for the protection of timber, and as a protection for streams; (2) the percentage and location of the principal forest types, together with their approximate stand of timber per acre of different species; (3) the most practicable methods of managing the different forest types to produce as nearly as possible the special kinds and amount of timber required by the industries; (4) the various methods of lumbering to determine the changes, if any, which may be recommended to improve the condition of the forest and to prevent unnecessary waste; (5) the annual amount of timber cut in the county and the uses to which it is being put, together with its approximate value on the stump and in the manufactured state; (6) the wood-using industries and their demands upon the forests; (7) the local and general markets for wood products; (8) other industries, such as farming, stock raising, and mining, in their relation to forests, in order that the relative importance of each may be determined; (9) the damage, costs, frequency, and effects of forest fires, with the object of working out some practical system of fire protection; (10) the practicability of planting in forest trees abandoned fields or other waste lands, with the object of preventing erosion and producing timber.

From these investigations of the several counties an approximate estimate can be made of the standing timber in North Carolina, and this has been found to be between 2,000 and 2,500 board feet per acre, or a total stand of merchantable timber of between 40,000,000,000 and 50,000,000,000 board feet.

DEMAND FOR TIMBER.

The wood-using industries of the State are second in value only to the cotton manufactures, and they are really of more importance than these, because they are scattered all over the State, and furnish employment to more men than any industry outside of agriculture.

In 1909 North Carolina was fourth among the States in the amount of lumber cut and second in the number of sawmills. In that year a total of 2,178,000,000 board feet of lumber was cut by 31,000 sawmills. Of this amount, our own manufactures took and worked up nearly one-

third. These factories, which turn out builders' supplies, furniture, vehicles, packing material, and many other things, obtain 96 per cent of their raw material from our own State. They complain, however, that the prices of this raw material are rising, the supply diminishing, and, what is worse still, the quality of the available timber rapidly declining.

North Carolina is first among all of the States of the Union in the amount of home production of timber used in the manufacturing of furniture. The furniture industry may be said to have begun in 1900. There are something over a hundred furniture factories in North Carolina, and of the ninety-one of which we have been able to obtain definite information, only twelve are reported to have been organized or commenced business prior to 1900. Of these twelve, only two were reported organized prior to 1890.

These factories are located in the following counties:

Alamance	4	Harnett	1
Buncombe	1	Haywood	2
Burke	2	Iredell	5
Cabarrus	1	Lee	2
Caldwell	8	McDowell	4
Catawba	3	Mecklenburg	1
Cherokee	1	Randolph	5
Davidson	11	Stokes	1
Davie	2	Surry	5
Forsyth	8	Wayne	1
Granville	1	Wilkes	2
Guilford	20		

In addition to the furniture manufacturing plants, there are other manufactures utilizing wood, as follows:

Manufacture of boxes and crates	45
Manufacture of coffins and caskets	7
Manufacture of cross-arms	3
Manufacture of excelsior	3
Manufacture of farming implements	5
Manufacture of flooring, ceiling, siding, etc.	132
Manufacture of fruit and vegetable packages	15
Manufacture of insulator pines	3
Manufacture of pipes, pulleys, and mine rollers	4
Manufacture of planking for boats	3
Manufacture of sash, doors, blinds, etc.	73
Manufacture of shuttles, spools, bobbins, etc.	7
Manufacture of tool and machinery handles	10
Manufacture of vehicles	35
Manufacture of woodenware	3

ANNUAL CUT.

There is an annual cut of merchantable timber in North Carolina of nearly 4,000,000,000 board feet, including lumber, shingles, ties, staves, pulpwood, poles, etc., or an average annual cut from the woodland of 200 board feet per acre. In addition to this, it is estimated that there are 5,720,000 cords, equivalent to nearly 3,000,000,000 board feet of cordwood, cut every year for firewood and other purposes. This means a total annual cut of what is equivalent to 350 board feet of timber per acre for all the woodland in the State.

ANNUAL GROWTH AND RESULT OF OVERCUTTING.

Our forests, in their present unprotected and mismanaged condition, are not, on an average, growing more than 150 board feet of wood per acre per year. With a cut of 350 board feet it is plain that we are annually using 200 board feet more of timber than the forests are producing. At this rate it will not be very long before we shall have used all the merchantable timber in the State.

By providing proper forestry regulations, this rapidly denuding of the North Carolina timber supply can be checked and the various industries dependent upon timber for their raw material can be made permanent industries.

EXAMINATION OF FOREST LANDS.

Two forest areas were examined during the past two years by the Forester, and as the recommendations given by the Forester and the owners of the property examined are of some general application to adjacent forest lands, these reports are given below:

REPORT ON AN EXAMINATION OF THE WOODLANDS ON THE PLANTATIONS BELONGING TO JUDGE WALTER CLARK, NEAR NORFLEET, HALIFAX COUNTY, NORTH CAROLINA.

The Clark plantations lie along the right bank of the Roanoke River, southeast of Norfleet, in the southeast corner of Halifax County. Several thousand acres of river bottom-land was comprised in the original Clark plantation. This, however, has been divided up amongst the various members of the family, and it is the part of this now owned by Judge Walter Clark,* of Raleigh, with which this report deals.

This is a plantation, or rather two of the plantations, with an area of about 1,200 acres, practically all of which is bottom-land and is subject to overflow in very high freshets. A dam or levee was until com-

*Judge Clark controls and manages an additional 400 acres.

paratively recently maintained around the greater part of the property in order to make the land safe against floods so that cultivation might be profitably carried on. In recent years, however, the dam has been broken in many places and there are now several large breaks which it would cost a great deal of money to repair. As a consequence, nearly all of this part of the country was inundated both this spring and last spring. Partly because of the frequent floods and the consequent risk in cultivating the land, and also because of the scarcity of labor in the region, much of the land even inside the dam has of recent years grown up to young growth, chiefly of sweet-gum, sycamore, river birch, and ash, together with a few other bottom-land species. Many of these areas are frequently burned over, in order, it is said, to keep them from growing up much faster. One result, however, is to destroy the humus and consequently harden the land, making it much more difficult to cultivate and the crops more susceptible to drought.

It is, however, of the areas outside of the dam that the principal examination was made. There are several hundred acres of the finest quality bottom-land nearest to the river which have never been protected by a dam. Parts of this land have at one time been cultivated, some of it quite recently.

It is on these recently cultivated areas that the owner has proposed the planting of walnut. He wishes to know whether the planting of walnut can be made a practical and profitable undertaking, and also whether any other measures can be taken to either improve the present stand of timber and young growth, or by planting any other species to profitably utilize the open areas.

The timber on these bottoms consists largely of species the seeds of which are sown by receding waters in times of flood, such as sycamore, ash, river birch, and sweet-gum, while in the lower places there is considerable bole gum and cypress. At present there is not any great demand for sycamore, birch, or cotton-wood timber, but there is no doubt that these species will bring a good price in a comparatively short time. Ash is at present the most valuable tree growing amongst the second growth, with the exception perhaps of walnut, which is scarce and of a small size. Ash will no doubt continue to be valuable timber. It should, therefore, be favored as much as possible by using the inferior species for firewood or other purposes.

At some places the second-growth stands are so dense that they do not grow as fast as if they were thinned out. Thinning, however, is not recommended unless a market can be found for material cut out. This, just at present, would be hard to do.

The recently cultivated areas seem admirably adapted for the planting of walnut. The soil is a rich alluvium of great depth, and where it is naturally drained walnut should and does grow very rapidly, as shown by some small trees seen on such situations. However, it is not recommended that the owner undertake the planting of walnut on any considerable scale, for two reasons: (1) because the land may in a short time be needed for agriculture; and (2) because it seems doubtful whether the planting of walnut will be a profitable investment of money.

(1) There is a project now being considered to organize this part of the county into a drainage area, with the object of completing and maintaining a strong dam or levee along the river and at the same time draining all the low-ground within the dam. The object would be not only to make available a large amount of very rich agricultural land, but also to improve the health conditions of the region by eliminating malaria. If this project is carried out, the land in question will become much too valuable for the growing of timber and will be wanted for the growing of agricultural crops. A walnut grove, which would take from 40 to 80 years to come to merchantable size, could never be made profitable, it is thought, on land worth $30 to $50 an acre.

(2) The generally advocated methods of planting walnut involve a considerable outlay of money both in planting and in cultivating for the first two or three years. For this reason the returns should be very large. Walnut, however, grows more slowly than many other species which would flourish on such situations. Again, its value depends largely on the color of its wood, which color does not develop until the tree is a considerable age. The trees would therefore have to occupy the ground much longer than some other species. Again, the fashion for walnut wood may by that time have been entirely superseded by some other, thereby eliminating the fancy market and placing it on a level with other timbers which can be produced at much less cost. For this reason the planting of walnut is not recommended on any large scale.

If the proposed plans for reclaiming this land are not carried out, and there seems no prospect for developing it for agriculture, certain small areas, such as are found in the major field south of the plantation house, and in the Edwards Island area, might be planted as an experiment.

The first of these areas was cultivated two years ago, and is now growing up in many places to young sweet-gum three to five feet high. The old corn rows are easily seen and the walnuts might be planted with a plow on the top of these ridges. The Edwards Island areas were cultivated two years ago, but last year grew up in enormous weeds, chiefly

giant ragweed or "sap weed," as it is locally called, six to twelve feet high. This would have to be kept down for two or three years until the walnut got a good start.

The following directions quoted from the Forest Service Circular, No. 88, *Forest Planting Leaflet on Black Walnut,* which I understand is at present out of print, are here given:

"The nuts may be stored over winter by stratifying them in moist sand or leaves in a sheltered place out of doors. In stratifying, three-inch layers of sand should alternate with single layers of nuts. Boards should be placed around the edge of this store of nuts and the top protected against burrowing rodents. The sand should be kept moist, and the whole mass allowed to freeze.

"For extensive and satisfactory propagation of the species, artificial planting is the only sure method. Because of the long tap-roots and consequent difficulty in transplanting, nursery culture is in general not advisable. . . .

"In general, the better plan is to omit nursery culture altogether and plant the nuts in their permanent place in the plantation. Either fall or spring planting may be practiced, but spring planting is usually best.

"In the East a furrow or a series of holes the proper distance apart will be sufficient for the reception of the seeds. On the plains and prairies of the West, greater care in preparing the soil is essential. The sod should be broken, and the ground put in corn or some other common crop for one or two years. The nuts may then be planted in the spring in shallow furrows and covered with a plow to a depth of two or three inches and the ground well firmed down. The rows should be straight in at least one direction, to facilitate cultivation. An interval of six or eight feet apart each way is recommended.

"Since the black walnut is a long-lived, light-demanding tree, it may with advantage be combined in the plantation with a more heavily foliaged species. The associate trees should be allowed to grow until they clear the lower limbs from the walnut and stimulate it to a rapid upward growth, when they should be removed and the long-lived species left to finish its growth alone. Desirable trees for such a mixture are the hardy catalpa, hackberry, osage orange, and the box-elder. When the walnut and another species are thus combined, the walnut should be given two or three years start, in order that it may not be overtopped.

"The plantation should be cultivated until the tops of the trees meet. During the first three years corn may be grown between the rows to give additional returns from the soil."

Box-elder would probably be the best species, for such land, to plant among the walnuts, as recommended above.

It has been suggested that to prevent depredations from squirrels and other rodents the nuts be rolled in and so covered with some distasteful material, such as tar or creosote, before planting, as is sometimes done

with corn. This seems a good idea, though of course adding somewhat to the cost of planting. Care must be taken, however, not to put on enough material to injure the nuts. J. S. Holmes, *Forester.*

Approved:

Joseph Hyde Pratt, *State Geologist.*

REPORT ON AN EXAMINATION OF THE WOODLANDS ON THE PROPERTY OF HALIFAX LAND CORPORATION, HALIFAX COUNTY, NORTH CAROLINA.

The property of the Halifax Land Corporation is situated in the southeast corner of Halifax County immediately north and west of Norfleet Station on the Atlantic Coast Line Railway. This property consists of two or three plantations fronting upon the Roanoke River, containing, together, several thousand acres of land, together with a tract of a thousand acres of woodland running back from the river three or four miles into the uplands towards Scotland Neck. These two areas we must consider separately, as they are so different in soil and forest condition, and the owner would wish to treat them in entirely different ways.

The Hall Woods.

This area of woodland, without any clearing upon the tract, lies three or four miles northwest of Norfleet and is entirely separate from the plantations owned by the same company. It was originally covered with a very heavy stand of loblolly pine timber, with a small admixture of short-leaf pine, and, on some of the more broken parts, a scattered stand of hardwoods. Eight years ago all the timber was cut, leaving only here and there a few small suppressed trees which have acted as seed trees, and some scattered cull hardwoods, chiefly white oak, black oak, sweet-gum, hickory, red maple, and Spanish oak. Some small yellow poplar from one to two feet in diameter seem to have been reserved, as was also some cypress in one or two small swamps. Since cutting, the greater part of the area has been burned over once or twice, killing more or less of the reproduction and seriously injuring what remains. However, there are some dense stands of loblolly pine from six to eight years of age and also a few stands somewhat older. Probably not more than one-third of the area, however, has on it an adequate stand either of pine or hardwood, for it is only in a few places that the hardwood has not been injured by fire, and the poorer species only survived.

The owner wishes to raise another crop of timber on this area and is willing to spend some money in order to improve the stand or increase the rate of growth.

This land is not what might be termed absolute forest land, for it is probably worth even in its present condition from $10 to $20 an acre, and, if cleared, would be worth twice as much. It is fairly good agricultural land, but, as labor is so scarce that even the cleared land on the river plantations cannot all be cultivated, it seems wisest to raise timber on the land until it shall be needed for farming. The principal thing to be done is to protect the area from fire. This is rather a difficult proposition in a country where practically everybody burns the woods, especially as this area has no houses upon it and is several miles distant from where the manager of the property lives. However, there are several steps that might be taken which should tend to reduce the danger from fire. First of all, let it be known definitely that the owner is anxious to prevent fires. This can be done by talking fire prevention amongst the neighbors and by putting up notices on the tract and also on the plantation to this effect. One of the large property owners in the neighborhood has had notices up for some time, and he says it has reduced the number of fires at least 10 per cent. Some suggested forms of such notice can be found in Economic Paper No. 19, published by the State Geological and Economic Survey. It might also be of advantage to have a man living on this tract. A small area of the best farming land might be cleared up and a man given house rent, even perhaps land, free of charge on condition that he would watch out for fires and summon assistance, if necessary, to extinguish them. In other words, he would act as a forest warden. This would not take a large part of his time, but during the dry and dangerous season he might have to do some patrol work. In this connection, a trail trimmed out all through the property over which the man might ride with ease, and rapidly if necessary, would be of great advantage. Even if the man did not live on the place, patrol during dangerous seasons, especially occasionally at night when there was danger of hunters being in the woods, would be a great protection, chiefly because it would make hunters and others more careful about setting fires, as they could not know when they might be discovered. A fire line in the most dangerous places along the boundary of the tract might be of considerable advantage, especially near the schoolhouse or church at the entrance to the property, where so much damage seems to have been done by fire. A place cleared out ten or fifteen feet wide, at fifty or one hundred yards distance from this church, might prevent any fire, that was started by smokers or others, from extending into the property.

There seems no necessity for thinning any of the dense pine stands. In some places a moderate, well directed thinning might increase the

rate of growth, but unless use could be found for the material cut out, it probably would not pay. Where small poles are needed for drying out peanuts or hay, they might with advantage be cut from such dense groves of pine, being careful always to cut only the smaller trees and leaving no large open places. In no case should openings be left which cannot be filled up with the branches of surrounding trees in five years time.

The poplar trees which are now on the property might with advantage be left for the present, in order to provide seed for reseeding the hardwood areas. As long as fire runs through the woods poplar seedlings cannot survive, but when protected from fire there is no reason why at least a percentage of the young growth should not be of this valuable species.

The cypress in the swamps need not be held for the silvicultural improvement of the property, but there is every reason to believe that cypress timber will greatly increase in value and warrant the retention of this timber for at least several years.

The Plantations.

A dam or levee has been maintained by these and adjoining plantations for a long time, to keep the Roanoke River from overflowing the extensive bottom-lands, so that they could be profitably farmed. This dam has of late years become broken in many places up and down the river, making the crops more or less uncertain. The Halifax Land Corporation has recently spent considerable money in repairing and improving the dam on their property, so that now all their bottom-land inside the dam is fairly well protected, except where the water is liable to back up from neighboring property on which the dams are still broken. There is, however, a large area of bottom-land outside of the dam which is covered with water at least once or twice a year. Much of this land was cultivated before the war, and some of it up to within comparatively recent years. Some of the lowest of it, however, is in timber of large diameter and has never been cleared at all. This is chiefly gum and cypress swamp. The soil is a red clay alluvium, and if protected from the river would be of very great value for agriculture. There is a scheme on foot now to form a drainage district and, with the coöperation of the Federal Government, to thoroughly levee and drain all this corner of the county, thus reclaiming a large amount of rich agricultural land and at the same time, it is hoped, greatly increasing the healthfulness of the region by getting rid of malaria. The lands outside the dam are now largely used for pasture, and for this purpose they are worth more to

the owners than for the production of timber. However, there are some fine young, even-edged stands of second growth of fairly good density, which are growing very rapidly and will within a short time produce some valuable timber. In some places small areas of mixed sweet-gum and river birch, in others pure cotton-wood or pure sweet-gum, while in another place can be found all of these mixed together or stands with an admixture of ash, walnut, and sycamore. The older stands of sycamore and other timber, which are long-bodied and clear of knots, show what may be expected of these younger stands. All of the species mentioned will no doubt be of commercial value in a few years time; even the despised sycamore and cottonwood will bring in good money.

There are some small areas of low-ground on which there is no grass and very little timber of any sort growing. It is suggested that these areas might be planted up to cottonwood, which makes an extremely rapid growth on these bottoms, a growth per year of one inch in diameter and five feet in height being found on this property. It is recommended that, if planting is undertaken, only a small area be planted to start with; then, if this succeeds, more could be undertaken next year. The following suggestions in regard to planting cottonwood are taken from the *Forest Planting Leaflet,* Circular No. 77, issued by the United States Forest Service:

"Propagation by seedlings or cuttings may readily be carried on. Large numbers of seedlings annually spring up on the sandbars, where one-year-old trees for establishing a plantation can be easily and cheaply procured. A plantation may be established rather more cheaply by cuttings than by seedlings. The cuttings should be made from one- or two-year-old branches of vigorous trees. Cuttings one-half inch in diameter and eighteen to twenty-four inches long are of desirable size for ordinary use. Much larger cuttings, however, can safely be used, and are often desirable where the erosion is very severe.

Planting.

"Seedlings or cuttings of the cottonwood should be set out in the spring as soon as danger from severe frost is past.

"Seedlings may be quickly and cheaply planted by a man and a boy working together. With a spade the man makes an opening in the ground into which the boy slips a tree. The spade is then withdrawn and the soil about the tree firmed immediately, before the man advances for the planting of the next one.

"Two-thirds of the length of the cutting should be below the surface of the ground, and on the portion above the ground there should be at least two or three good buds.

"In planting groves on permanently moist situations the trees should be set six to eight feet apart each way.

Cultivation and Care.

"The growth of the cottonwood is so rapid where conditions are at all favorable that it is seldom, if ever, subject to the crowding or overtopping of less desirable species.

"Plantations should not be used for pasturage for at least five years. Grazing animals not only eat the tender shoots and leaves, but expose and cut off the roots by trampling the ground around the trees.

"Fire is one of the most serious enemies of this tree, both in planted groves and natural forests. Protection can readily be secured by plowing several furrows around the plantation. If the furrows are kept free from weeds, fire will be effectually kept out. Where this is not possible a path or fire lane entirely surrounding the plantation should be raked free of leaves and débris. In the spring and fall, when the danger from fire is greatest, the plantations should be kept under observation, and all fires should be extinguished immediately."

If the plan for leveeing and draining these areas should be carried out, all this land will undoubtedly be cleared up for agriculture, so that these recommendations will not be carried out.

Approved: J. S. Holmes, *Forester.*

Joseph Hyde Pratt, *State Geologist.*

SPECIAL FOREST INVESTIGATION.

CHESTNUT BARK DISEASE.

During 1913 investigations were continued in connection with the chestnut bark disease, under the same agreement with the Chief of Forest Pathology of the United States Department of Agriculture and the Chief of Plant Diseases of the State Agricultural Experiment Station of Raleigh. Messrs. P. L. Buttrick and Stephen C. Bruner continued this investigation under the supervision of the State Forester during most of the year of 1913.

The only locality where chestnut bark disease was discovered in North Carolina was in some cultivated chestnuts in the nurseries of J. Van Lindley, of Pomona, Guilford County. Out of two hundred trees of fruit-bearing size only thirteen were not infected. Some smaller trees in the nursery were also infected. Mr. Van Lindley, at the suggestion of the Survey, took prompt measures to eradicate this disease by cutting down all the large trees and digging up the small ones and burning them and then cleaning the ground thoroughly.

Intensive scouting work by Mr. Stephen C. Bruner, Dr. Kent Beattie, of the Bureau of Plant Industry; Mr. J. S. Holmes, State Forester, and

Mr. P. L. Buttrick, agent Bureau of Plant Industry, was carried on in and around Guilford County to see if this blight had extended to any of the native trees. A small area of native chestnut trees close to Guilford College, a few miles from Pomona, were found to be infected, but these were cut down and burned and the ground cleaned. No further areas of infection were discovered, and it is believed that the blight started by the imported trees has been eradicated.

As a result of this investigation the State Survey has material on hand, which is nearly ready for publication, on the commercial value and distribution of the chestnut in North Carolina, a report on the recession of the chestnut, and maps showing its distribution. These reports will be published during the coming year.

ASH IN NORTH CAROLINA.

By W. D. Sterrett.

A brief study has been made of the distribution and cut of ash in North Carolina, by Mr. W. D. Sterrett, of the United States Forest Service, assisted by Mr. J. S. Holmes, State Forester. A short report has been prepared descriptive of the work done and the results obtained.

Species of Ash.

There are six different species of ash occurring in North Carolina, which are briefly described below:

White ash (*F. americana*). At present the most important commercial species. Has good silvicultural possibilities as a tree for forest management in the mountain and Piedmont regions, and in well-drained upland ravines in the Coastal Plain. Requires a moist, well-drained soil.

Biltmore ash (*F. biltmoreana*). A pubescent form of white ash, suited to somewhat drier sites and has a more rugged growth in youth. It is at present of slight commercial importance, because of its comparative infrequent occurrence, but has excellent silvicultural possibilities in the mountain and Piedmont regions. At the Biltmore nurseries it has been grown with much greater success than the white ash.

Green ash (*F. lanceolata*). A very important tree commercially and silviculturally for the Coastal Plain region and for overflow land in the Piedmont region. Has excellent possibilities as a tree for forest management. Good natural reproduction, and easy to grow in the nursery.

Red ash (*F. pennsylvanica*). A pubescent form of green ash of very infrequent occurrence and of no commercial importance, at present, in

the State. Has good silvicultural possibilities as a substitute for green ash on drier sites in the Coastal Plain and Piedmont, where it will grow faster than the green ash. Seed of this species is scarce in the State.

Pumpkin ash (*F. profunda*). A large-seeded, pubescent form of green ash found in mixture with it and on wetter land in deep swamps. Has some commercial importance and excellent silvicultural possibilities. Under the same conditions it is more rapid growing than green ash, and will also grow on wetter and less favorable sites than green ash. The chief drawback, silviculturally, is scarcity of seed supply.

Water ash (*F. caroliniana*). This is a small tree of the deep swamps in the Coastal Plain, whose chief value is for firewood. An occasional log of it may be cut for lumber. The wood is brash and inferior. It is of no importance as a tree for forest management.

Annual Cut.

The annual cut in the State varies considerably from year to year, but in no year does it amount to a very large proportion of the total cut in the United States. In the following table are given figures giving the amount of ash lumber annually cut in North Carolina and the total amount cut in the United States, these figures being taken from the United States census reports:

Table 1.—Annual Cut of Ash in North Carolina and United States from 1899-1912.

Year.	Ash Cut in State, M ft., B. M.	Rank of State in Ash Production.	Total Cut of Ash in U. S., M ft., B. M.
1899	3,617	Sixteenth	269,120
1909	4,476	Seventeenth	291,209
1910	3,426		234,715
1911	3,197		214,398
1912	5,473	Fifteenth	234,548

By far the greater percentage of the ash cut in North Carolina is from the mountain region and is a white ash.

There is given in the table below the amount of ash cut in the three general regions in North Carolina and the percentage of each species cut in these regions during 1910:

Table 2.—Cut of Ash by Regions and Species, 1910.

Region.	Cut of Ash, M. B. F.	Per Cent of Species Cut.	
		White Ash,* Per Cent.	Green Ash,† Per Cent.
Mountain (70 per cent of total)	2,379	100	0
Piedmont (5 per cent of total)	182	50	50
Coastal Plain (25 per cent of total)	865	10	90
Total	3,426		

*A small per cent of this is Biltmore ash—5 to 10 per cent.
†5 to 10 per cent of this is pumpkin and water ash.

The ash is pretty generally distributed throughout the State, and forty-eight counties assisted in the 1910 production of this type of timber, as follows:

Table 3.—Cut of Ash in North Carolina by Counties in 1910.

County.	Cut of Ash, M. B. F.	County.	Cut of Ash, M. B. F.
Alamance	30	Jackson	28
Alleghany	8	Jones	20
Alexander	1	Lenoir	20
Ashe	530	Lincoln	6
Beaufort	31	McDowell	10
Bertie	14	Macon	6
Buncombe	87	Madison	249
Burke	136	Martin	6
Caldwell	2	Mitchell	255
Caswell	5	Moore	2
Catawba	4	Nash	52
Chatham	10	Northampton	2
Cherokee	10	Onslow	100
Clay	12	Pasquotank	25
Craven	155	Pender	38
Davidson	1	Pitt	110
Davie	5	Randolph	25
Duplin	220	Rowan	1
Forsyth	2	Stanly	5
Gates	2	Swain	389
Graham	273	Transylvania	2
Guilford	16	Watauga	251
Haywood	145	Wayne	10
Hertford	60	Yancey	51

Rate of Growth and Yield.

Considerable interesting information during the course of investigation was obtained regarding the rate of growth and yield of the different species of ash on different types of soil and in different regions. In

Table 4 there are given figures indicating the rate of growth of green ash on a typical green ash site, but in an overcrowded stand. Under management, an average rate of growth equal to that of a fast growth, given in the table, could be reasonably expected.

Table 4.—Rate of growth of green ash on old field river bottom land, Iredell County, North Carolina, in a very dense, even-aged, unthinned stand.

Age, Years.	Fast Growth.		Average Growth.		Basis.
	Diameter Breast-high, Inches.	Height, Feet.	Diameter Breast-high, Inches.	Height, Feet.	
10	3.1	32	1.7	23	
15	----------	44	----------	35	
20	6.2	53	3.7	45	
25	----------	61	----------	53	
30	8.7	68	5.6	59	Sectional age counts
35	----------	73	----------	65	on 20 trees 60 years
40	10.7	78	7.2	69	old.
45	----------	82	----------	73	
50	12.5	85	8.9	77	
55	----------	87	----------	80	
60	14.1	90	10.5	82	

Table 5 gives the rate of growth of green ash under favorable conditions on overflow river bottom-land in South Carolina.

Table 5.—Rate of growth of green ash on overflow river bottoms in Orangeburg County, South Carolina.

Age, Years.	Fast Growth.		Average Growth.			Basis.
	Diameter Breast-high, Inches.	Height, Feet.	Diameter Breast-high, Inches.	Height, Feet.	Maximum Old Field Height Growth, Feet.	
5	2.5	23	1.0	15	----------	
10	5.3	39	2.4	26	46	
15	7.5	49	3.8	34	----------	
20	9.4	57	4.9	41	71	
25	10.2	64	6.0	47	----------	
30	12.8	69	7.1	52	88	
35	14.3	75	8.1	57	----------	Decade measurements
40	15.7	79	9.1	62	101	on 410 2-foot stumps
45	17.1	83	10.0	66	----------	32 to 180 years
50	18.5	87	11.0	70	110	old, and complete
55	19.8	91	11.9	74	----------	analyses on 115 of
60	21.1	95	12.9	78	117	these trees.
65	22.3	98	13.8	81	----------	
70	23.5	101	14.7	84	122	
75	24.7	104	15.6	88	----------	
80	25.9	107	16.4	90	125	
85	27.1	110	17.3	93	----------	
90	28.2	112	18.1	96	----------	

Table 5—Continued.

Age, Years.	Fast Growth.		Average Growth.			Basis.
	Diameter Breast-high, Inches.	Height, Feet.	Diameter Breast-high, Inches.	Height, Feet.	Maximum Old Field Height Growth, Feet.	
95	29.4	115	18.9	98	----------	
100	30.5	117	19.7	100	----------	
105	31.6	119	20.5	102	----------	
110	32.6	121	21.3	104	----------	
115	33.7	122	22.1	106	----------	
120	34.8	124	22.9	107	----------	
125	35.8	126	23.6	108	----------	
130	36.9	127	24.4	110	----------	
135	----------	129	25.2	111	----------	
140	----------	130	26.0	112	----------	
145	----------	132	26.7	113	----------	
150	----------	133	27.5	114	----------	

Table 6 gives the rate of growth of white ash in even-aged second-growth unmanaged stands, growing under favorable conditions in New York. Under management in North Carolina, on favorable upland sites, it should be possible to get an average growth equal to that given for fast growth in this table.

Table 6.—Rate of growth of white ash on moist upland clay soil, Otsego County, New York.

Age, Years.	Fast Growth.		Average Growth.		Basis.
	Diameter Breast-high, Inches.	Height, Feet.	Diameter Breast-high, Inches.	Height, Feet.	
10	2.1	25	1.3	17	
15	3.7	38	2.4	27	
20	5.3	50	3.5	36	
25	6.7	59	4.5	43	
30	8.0	67	5.4	49	
35	9.2	73	6.2	55	
40	10.2	77	6.9	59	
45	11.2	81	7.6	63	Complete stem analyses on 47 trees, mostly 80 to 100 years in age.
50	12.0	83	8.3	66	
55	12.9	85	8.9	69	
60	13.7	87	9.5	71	
65	14.5	88	10.1	73	
70	15.2	89	10.6	75	
75	16.0	90	11.2	77	
80	16.7	92	11.7	79	
85	17.3	93	12.2	81	
90	17.9	94	12.6	82	
95	18.5	95	13.1	83	
100	19.1	97	13.6	85	

Table 7 shows the rate of growth of even-aged second-growth white ash on sandy loam soil in New York, where the thinning out was more rapid, giving fewer trees per acre but larger average diameters and lesser heights; lesser cubic feet per acre yield, but greater board feet per acre yield.

Table 7.—Rate of growth of white ash on fresh to moist upland sandy soil, Oswego County, New York.

Age, Years.	Fast Growth.		Average Growth.		Basis.
	Diameter Breast-high, Inches.	Height, Feet.	Diameter Breast-high, Inches.	Height, Feet.	
10	2.5	29	1.3	17	
15	5.5	42	3.0	27	
20	8.2	52	4.5	34	
25	10.4	60	5.9	41	
30	12.2	67	7.1	47	
35	13.9	71	8.3	53	
40	15.3	75	9.4	57	Complete stem analyses on 138 trees 28 to 99 years old.
45	16.6	78	10.3	61	
50	17.7	79	11.2	65	
55	18.7	81	12.2	68	
60	19.6	81	13.1	71	
65	20.4	82	13.9	74	
70	21.2	83	14.8	76	
75	22.0	82	15.6	78	
80	22.8	83	16.5	81	

These tables (4, 5, 6, and 7) are given as an indication of the possibilities of growth under favorable conditions. The average rate of growth of ash in all-aged selection forests, under natural conditions, would be considerably slower.

Table 8 is a yield table showing the yield possibilities of pure, even-aged, well-stocked stands of ash, such as could be grown under management. It is based on measurements of 63 plats taken in stands, mostly of natural white ash, second growth, but also some planted stands.

Table 8.—Yield of pure, even-aged, well-stocked stands of ash on different quality sites.

Age, Years.	Number of Trees Per Acre 3 in. and Over.	Average Diameter Breast-high, 3 in. and Over.	Yield Per Acre.		
			Scribner Dec. C. 7 in. and Over.	3 in. and Over.	
			Board Feet.	Cubic Feet.	Cords.
		QUALITY I.			
	Inches.	*Inches.*			
20	427	5.4	2,000	2,200	24.4
25	391	6.5	4,200	3,100	34.4
30	375	7.5	6,500	3,900	43.3
35	361	8,3	9,000	4,600	51.1
40	341	9.1	11,700	5,250	58.3
45	322	9.9	14,700	5,830	64.8
50	288	10.5	18,000	6,350	70.6
55	251	11.2	21,700	6,600	75.6
60	224	11.8	25,700	7,220	80.2
65	203	12.4	29,500	7,600	84.4
70	188	13.0	32,800	7,950	88.3
75	176	13.5	35,600	8,280	92.0
80	166	14.0	38,000	8,600	95.6
		QUALITY II.			
20	482	4.0	----------	850	9.4
25	435	5.0	1,000	1,680	18.7
30	415	5.8	2,200	2,400	26.7
35	393	6.6	3,600	3,050	33.9
40	378	7.4	5,300	3,630	40.3
45	367	8.0	7,500	4,130	45.9
50	361	8.7	9,900	4,590	51.0
55	350	9.03	12,700	5,000	55.6
60	340	9.80	15,700	5,380	59.8
65	326	10.4	19,100	5,720	66.8
70	309	10.9	22,600	6,010	66.8
75	288	11.5	25,500	6,270	69.7
80	268	12.0	28,000	6,520	72.4
		QUALITY III.			
25	469	3.5	----------	470	5.2
30	456	4.2	----------	970	10.8
35	452	4.9	300	1,470	16.3
40	426	5.3	1,300	1,950	21.7
45	410	6.2	2,400	2,400	26.7
50	402	6.8	3,900	2,790	31.0
55	392	7.3	5,600	3,150	35.0
60	382	7.9	7,700	3,470	38.6
65	377	8.4	10,200	3,760	41.8
70	371	8.9	12,900	4,020	44.7
75	365	9.3	15,700	4,260	47.3
80	359	9.8	18,000	4,490	49.9

Based on 18 plats, Quality I; 30 plats, Quality II; 14 plats, Quality III, with a total area of 16.9 acres.

LOBLOLLY OR NORTH CAROLINA PINE.

The loblolly or North Carolina pine is by far the most important tree now being cut for lumber in North Carolina. While distributed over only the eastern half of the State, yet this tree furnishes more than one-half of the annual lumber cut of the whole State. Most of the lands which many years ago were denuded of long-leaf pine by the turpentine operators and lumbermen, and then devastated by fires and hogs, later came up to loblolly pine, and now, fifty to one hundred years later, are furnishing another and a more remunerative crop of timber than the long-leaf pine at the time it was previously put on the market.

Loblolly combines all the essentials for an ideal forest management tree. It seeds profusely and regenerates readily, is adapted to nearly all types of soil, grows rapidly, becomes marketable at an early age, grows densely, making large yields per acre, and produces material for which there is general demand at a fair and increasing price. A thorough study of this tree has been made, and the final investigations were completed in 1913. This investigation has been conducted chiefly by Mr. W. W. Ashe, former State Forester of the Survey and now Forest Inspector of the United States Forest Service.

The results of the investigation are published in Bulletin 24, which takes up particularly the growth and proper forest management of loblolly pine in North Carolina. It also deals with the occurrence and silvical requirements of the tree, its growth in height, diameter, and volume on different soils and situations; the yields which can be obtained under varying conditions, and the amount of lumber of different grades which can be cut from timber of different ages and qualities.

This report has been prepared for the use of landowners and lumbermen alike, and is designed to meet the needs of all our people who are in any way interested in timber, but especially those in the eastern half of North Carolina.

WATER SUPPLY OF CITIES AND TOWNS.

A study of the watersheds of the cities and towns of the State has been started, in coöperation with the State Board of Health. A list of questions has been prepared to be sent out to all officials in charge of city water-works. It is proposed to compile the information received in answer to these questions, together with other material that can be furnished by the Board of Health and by the State Survey, in an Economic Paper on the *Care of Watersheds of Cities and Towns,* especially in relation to forest fires and erosion.

The watershed on Buffalo Creek was examined by the Forester the latter part of August, 1914, at the request of Mr. Leslie McGinniss, secretary, Kings Mountain Progressive Association, and recommendations made regarding how to reduce erosion.

STREET TREE PLANTING.

On January 27th and 28th the Forester assisted Dr. W. C. Coker, Professor of Botany in the University of North Carolina, in securing sixty-five willow oak trees and planting same along the streets of Chapel Hill. The State Survey is ready to assist, as far as its limited appropriation will permit, any city or town or public institution in the care of its trees and the planting of trees.

SPECIAL FOREST FIRE REPORTS.

A special circular regarding forest fires was published in the summer of 1913, and a special appeal was sent out to all members of the North Carolina Forestry Association to assist in distributing this forest-fire circular to the children of the public schools. The circular, which was prepared and published by the Survey, was distributed by the Forestry Association, it making a special appropriation for this purpose. Thus far about 43,000 copies of this circular have been distributed throughout the State.

A special press article was prepared and sent out in April to many of the newspapers on *The Imminent Danger of Spring Forest Fires.*

SPRUCE FORESTS ON MOUNT MITCHELL.

There was a very serious forest fire that raged around Mount Mitchell on July 23d through 26th. The Forester made an investigation regarding the damage by this fire to the spruce forests of the Black Mountains. A report regarding this investigation is given below:

All those who have visited Mount Mitchell during the past summer must have been greatly shocked by the change which has been brought about in the scenery. Lumbering operations followed by fire have practically destroyed the forests upon this mountain and the near-by peaks which have given the Black Mountains their name. The dark green spruce forests which stretched all along the higher easterly slopes and down into the heads of the coves where they met the lighter green of the hardwoods have disappeared. In their place an almost unbroken area of charred stumps and logs, blackened trees, dead saplings, and bare rocks extends from Toe River Gap, across Clingman's Peak, practically up to the summit of Mount Mitchell itself.

North Carolinians have come to look upon this mountain (Mount Mitchell) as peculiarly their own; and though it is so surrounded by other mountains that comparatively few people have seen it, and fewer still have made the arduous climb to its summit, yet all are deeply interested in its natural attractions and would deeply regret the destruction of its beauty or of its usefulness. Its association with the labors and tragic death of the beloved Elisha Mitchell, State Geologist and professor in the University, has made it a household word in North Carolina, while its elevation of 6,711 feet above sea level makes its name familiar to every school boy and girl in the country as the highest peak east of the Rocky Mountains.

The Black Mountains extend from the Craggies north to Mount Celo, a distance of some fifteen or twenty miles. They run almost parallel to the Blue Ridge, and in one place are only separated from it by a low gap. In this length there are some twenty peaks over 6,000 feet high and six over 6,600 feet. On this range occurs the largest stretch of spruce forest in the State, a type which chiefly belongs to the far north and which has its extreme southern limit in the Balsam Mountains, fifty miles west of here.

Cutting of Spruce.

About two years ago what is called development of this area commenced. A narrow-gauge railroad was built to these spruce forests in Yancey County from Black Mountain station, where a large sawmill was installed. Already about twenty miles of road have been constructed and extensions are being pushed. The line already reaches to within less than a mile of the top of Mount Mitchell. Approximately 1,000 acres of spruce has already been cut, wood down to four inches in diameter being taken. The small material is shipped out for pulp, while the larger is cut into lumber. Repeated fires have burned over these cut-over lands, sometimes extending into the near-by standing timbers, until the whole area seems to be reduced to a blackened and desolate waste. The vegetable soil, which is essential for the growth of the spruce, has been destroyed, and erosion of the steep hillsides has already commenced. It seems very uncertain whether these burnt areas can ever again become reforested with the spruce, and it is certain that it cannot for a great many years to come, probably not within the life of this or the next generation.

Results.

The beautiful scenery of these mountains is one of western North Carolina's greatest assets. The care of visitors is perhaps the most important industry of the region. The destruction of the beautiful is therefore a serious money loss to a large number of our citizens. The esthetic and sentimental value of these grand mountain forests cannot be estimated. Its destruction can only be compared to that of Niagara Falls, which has so seriously been threatened by the development of water power there and which has been so strenuously combatted for years by almost the whole American people. There is this difference however: the falls cannot be fully utilized without destroying their scenic value, while the spruce forests can be utilized while still retaining much of their beauty and a large part of their usefulness.

But the baring of these mountain-sides has an even more direct detrimental effect on the county and region. The heavy rains, which formerly have been absorbed by the spongy soil, feeding the streams quite slowly through innumerable ice-cold springs, will now run off the dry, hard surface directly into the creeks and rivers. This will undoubtedly cause worse floods than have ever been experienced, and the rich bottom-lands along the Toe and Cane rivers will be practically ruined. In addition, the water powers throughout the whole length of the streams which head on these lands will be greatly reduced in effectiveness and value.

The destruction of the producing value of the land itself, however, is one of the greatest losses. For ten thousand acres of land, capable of growing from five to ten thousand dollars worth of timber a year, to be made absolutely nonproductive, means a very serious loss, not only to the owners themselves, but also to the whole State. The taxable valuation of the property will become nothing, and the available supply of timber, which our industries need more and more each year, will be reduced by that much.

What Can Be Done?

The question is, What is to be done? It is easy enough to say, Cutting must be regulated and fire prevented! But how is this to be accomplished, and who is to do it?

With the exception of a few acres on the top of the mountain, all the land in question now belongs to two large companies, who together own some 21,000 acres on the heads of Cane and South Toe rivers on either slope of the Black Mountains. Because of the good quality of the timber and the rapidly growing scarcity of such tracts, exceptionally high prices are said to have been paid for this land. If reports are true, the operating company purchased all the spruce and balsam timber on these two tracts, paying the landowners an excessive price per thousand feet for the stumpage. Logging over twenty miles of narrow-gauge railroad is very expensive, which is added to by the difficulty of the country; so unless logging costs can be kept down to a minimum, not only will no money be made, but heavy losses will be sustained. Under these circumstances the operating company does not feel able to incur any great expense to protect from fire lands which it does not own.

The company has, however, itself suffered severely from fire, especially during the past summer. In May a fire destroyed six or eight thousand dollars worth of logs and two or three workmen's shacks. Again in June fire got out from one of the engines and burnt up $10,000 worth of logs already skidded into piles, and destroyed the commissary with a $5,000 stock of goods, a boarding-house and seven shacks. The two fires caused a loss of at least $20,000 to the company.

It would not be fair to say that this loss could have been prevented if fire protective measures had been adopted, but it is no doubt true that had an adequate fire preventive system been in operation the risk of such damage would have been much smaller.

In the absence of any agreement to that effect, the operating company cannot be required to protect the lands of another company from fire, even though it incidentally protected its own property, when, as has been seen, it would

mean virtual confiscation. The only practicable plan is for the State itself to organize protection. This company and others like it could then be induced to join with the State in protection work.

In practically all parts of the United States, as well as in Canada, where spruce forests occur, the State and the private owner coöperate in fire protection. Such coöperation in many regions includes a third party, the National Government; and in western North Carolina the Federal Forest Service stands ready to assist as soon as the State takes hold.

Federal Purchase Not Possible.

It has often been suggested that the Federal Government buy these lands for incorporation in the Appalachian National Forest. The purpose of the Weeks Law is to provide for the purchase of just such lands, for "the protection of the watersheds of navigable streams." The Government has already secured large tracts of forest land on each side of the areas in question, so that it seems the simplest and most natural thing for it to buy these. This would certainly be a most desirable solution of the problem. On all our National Forests thorough fire protection is maintained, and cutting is regulated according to the various types of forest and the purpose for which it is maintained. If the Forest Service could secure these lands they would immediately go under the best kind of forest management.

The Government has already approved for purchase about 240,000 acres of forest land in North Carolina, yet no spruce lands are included in these reserves. This is because spruce timber has been sold and is still held at such very high prices that the National Reservation Commission would not think of approving purchases at such prices.

The Murchison boundary, as the tract on the head of Cane River is better known, is said to have brought over $30 per acre the last time it changed hands, and no doubt the owner expects to get a profit on this in the sale of his timber. The Government cannot and will not pay any such prices for land, so naturally it is impossible for them to purchase spruce areas.

In New Hampshire the Commission has recently approved for purchase about 85,000 acres, including Mounts Washington, Adams, and Jefferson. This tract contains about 70,000,000 feet of spruce timber or less than 1,000 feet per acre, yet, urged by public opinion "which strongly favored the Government's ownership," the Commission consented to pay $8.50 per acre for it, "a price which was felt to justify its purchase."

The hopelessness of expecting the Government to pay $30 per acre, even though Mount Mitchell is 418 feet higher than Mount Washington, is apparent. The only alternative is State protection, and unless the State can take some action to protect these grand forests from fire, they are doomed to destruction.

All that is necessary is the passage of a law establishing the rudiments of a State forest protective system and carrying a small appropriation. With this as a beginning and with the coöperation of the United States Forest Service which has already been guaranteed, organized fire protection could be started. The hearty coöperation of the landowners and of the operating company would naturally follow. Thus would be formed a triple alliance of

the private owner, the State, and the Federal Government, which has in the past proven the strongest possible combination for preventing forest fire destruction. No other plan seems to offer any permanent relief.

FORESTRY LECTURES.

FORESTRY LECTURES IN CONNECTION WITH FARMERS' INSTITUTES.

In coöperation with the State Department of Agriculture, the Forester has each summer joined one of the Farmers' Institute parties in the Piedmont and Western sections of the State and made talks on various forestry problems. The lectures were devoted principally to the question of the management of forest areas, and particular attention was given to the relation of these areas to the farm. The importance of such a study in connection with better farm management is more thoroughly appreciated when it is realized that from one-third to one-half of the average farm in North Carolina is in woods. It is just as important, therefore, for the farmer to have expert advice as to how to grow and sell his timber to the best advantage as how to improve his soil or market his other crops.

Talks and discussions on various phases of forest management, such as "Protecting the Woodlands from Fire," "Selecting Shade Trees," "Protecting the Young Growth from Stock," "Improving the Stand," "Thinning the Wood-lot," "Wood-lots for the Farm," "Cutting Timber," "Selling Timber," "Securing the Second Crop," should be held in connection with every Farmers' Institute held in the State. With the present appropriation, however, it is impossible for the Survey to assist the farmers' institutes to this extent. It is hoped, however, that an additional appropriation can be made to the Geological and Economic Survey that will enable it to extend this phase of its work.

During 1913-1914 the following talks were made by the Forester:

Addresses by the Forester of the North Carolina Geological and Economic Survey at Farmers' Institutes.

Place.	County.	Date.	Subject of Address.	Number Attending.	
				Women.	Men.
Ogden	Clay	July 22, 1913	Forest Fire Prevention		20
Elf	Clay	July 23, 1913	Timber-cutting and Fire Prevention		25
Hayesville	Clay	July 24, 1913	Soil Erosion		40
Hayesville	Clay	July 24, 1913	Forest Fire Prevention		15
Hayesville	Clay	July 24, 1913	Shade Trees	30	
Andrews	Cherokee	July 25, 1913	Improvement of Farm Wood-lots		55
Bryson City	Swain	July 26, 1913	Reproducing the Poplar		22
Quallatown	Jackson	July 28, 1913	Improvement of Farm Wood-lots		30
Cullowhee	Jackson	July 29, 1913	Improvement of Farm Wood-lots		19
Higdonville	Macon	July 30, 1913	Improvement of Farm Wood-lots		90
Higdonville	Macon	July 30, 1913	Shade Trees and Fire Protection	40	
Maxwell Schoolhouse	Macon	July 31, 1913	Improvement of Farm Woodlands		22
Franklin	Macon	Aug. 1, 1913	Planting and Seed Tree Selection		25
Otto	Macon	Aug. 2, 1913	Improvement of Farm Woodlands		30
Columbus	Polk	Aug. 4, 1913	Improvement of Farm Woodlands		75
Green River School	Henderson	Aug. 5, 1913	Improvement of Farm Woodlands		31
Selica	Transylvania	Aug. 6, 1913	Improvement of Farm Woodlands		18
Mills River Academy	Transylvania	Aug. 7, 1913	Improvement of Farm Woodlands		35
Liberty Schoolhouse	Henderson	Aug. 8, 1913	The Growth of Trees		51
Bethel	Haywood	Aug. 9, 1913	Improvement of Farm Woodlands		*40
Rock Hill	Haywood	Aug. 11, 1913	Improvement of Farm Woodlands		28
Democrat	Buncombe	Aug. 12, 1913	Improvement of Farm Woodlands		48
Democrat	Buncombe	Aug. 12, 1913	Bird Protection	30	
Mars Hill	Madison	Aug. 13, 1913	Improvement of Farm Woodlands		50
Mars Hill	Madison	Aug. 13, 1913	Growing Locusts for Posts on Old Fields		50
Marshall	Madison	Aug. 14, 1913	Improvement of Farm Woodlands		18
Old Fort	McDowell	Aug. 15, 1913	Improvement of Farm Woodlands		30
Lowe's Grove	Durham	July 27, 1914	Increase in Yield of Woodlands		35
West End	Moore	July 30, 1914	Improvement of Farm Woodlands		100
Big Oak	Moore	July 31, 1914	Planning for and Protecting the Second Crop of Timber		100
Candor	Montgomery	Aug. 1, 1914	Improvement of the Farm Wood-lot		80

Candor	Montgomery	Aug. 1, 1914	Forest Fires and Improvement of School Grounds	60	
Ellerbe	Richmond	Aug. 3, 1914	Improvement of Farm Woodlands		95
Star	Montgomery	Aug. 4, 1914	Improvement of Farm Woodlands		50
Star	Montgomery	Aug. 4, 1914	Pine Bark Beetle		40
Star	Montgomery	Aug. 4, 1914	Tree Growth and Forest Fires	80	
Troy	Montgomery	Aug. 5, 1914	Improvement of Farm Woodlands		*110
Hannersville	Davidson	Aug. 6, 1914	Improvement of Farm Woodlands		35
Marion	McDowell	Aug. 7, 1914	Improvement of Farm Woodlands		60
Burnsville	Yancey	Aug. 8, 1914	Improvement of Farm Woodlands		20
Bear Creek	Chatham	Aug. 10, 1914	Fire Protection		†140
Bear Creek	Chatham	Aug. 10, 1914	Improvement of Farm Woodlands		70
Day Book	Yancey	Aug. 11, 1914	Fire Protection		†70
Day Book	Yancey	Aug. 11, 1914	Improvement of Farm Woodlands		50
Bakersville	Mitchell	Aug. 12, 1914	Erosion and Improvement of Farm Woodlands		65
Spruce Pine	Mitchell	Aug. 13, 1914	Forest Fires and Reproduction		†100
Spruce Pine	Mitchell	Aug. 13, 1914	Improvement of Farm Woodlands		25
Waco	Cleveland	Aug. 15, 1914	Management of the Farm Wood-lot		75
Sunnyside Schoolhouse	Gaston	Aug. 17, 1914	Management of the Farm Wood-lot		175
Crouse	Lincoln	Aug. 18, 1914	Management of the Farm Wood-lot		150
Crouse	Lincoln	Aug. 18, 1914	Pine Bark Beetle		100
Reepsville	Lincoln	Aug. 18, 1914	Management of the Farm Wood-lot		75
Reepsville	Lincoln	Aug. 18, 1914	Forest Protection		60
Lincolnton=	Lincoln	Aug. 18, 1914	Forestry for North Carolina	‡80	
Lincolnton	Lincoln	Aug. 20, 1914	Improvement of Farm Woodlands		60
Lincolnton	Lincoln	Aug. 20, 1914	Forest Protection		65
Stanley	Gaston	Aug. 21, 1914	Management of the Farm Wood-lot		85
Stanley	Gaston	Aug. 21, 1914	Protection of Woodlands		25
Woodleaf	Rowan	Aug. 22, 1914	Improvement of Farm Woodlands		75

*Includes both men and women. †Children. ‡Teachers.

=Through the courtesy of Professor Highsmith, of Wake Forest, who was conducting a teachers' institute at Lincolnton, the Forester had the opportunity of addressing eighty teachers, who were attending the institute, on the subject of "Forestry for North Carolina."

At many of these farmers' institute meetings the Forester had an opportunity to distribute forest-fire circulars to school children, and in many instances had a chance to explain the object of the circular.

SPECIAL ADDRESSES BY THE FORESTER.

The Forester made the following special addresses and lectures:

February 19, 1913.

At Greensboro, N. C., before the Colored Agricultural and Mechanical College, on the *Care of the Farm Wood-lot.*

March 25, 1913.

At Asheville, N. C., before the directors of the American Forestry Association, on *Forest Conditions in North Carolina.*

April 4, 1913.

At Red Springs, N. C., before the Southern Presbyterian College, on the *Conservation of Our National Forests.*

November 5, 1913.

At Chapel Hill, N. C., before the Chapel Hill public school, on *Trees and Their Value.*

July 8, 1914.

At Chapel Hill, N. C., before a class of the Summer School of the University of North Carolina, on *Forest Regions of the United States, and Forest Regions and Types in North Carolina.*

July 9, 1914.

At Chapel Hill, N. C., before a class of the Summer School of the University of North Carolina, on *Forestry for the Private Owner.*

July 10, 1914.

At Chapel Hill, N. C., before a class of the Summer School of the University of North Carolina, on *Forest Protection and Its Broader Aspects.*

July 17, 1914.

At Chapel Hill, N. C., before the Summer School of the University of North Carolina, on *Our Forests and Their Protection.*

On January 8, 1913, Mr. Holmes represented the North Carolina Geological and Economic Survey at the annual meeting of the American Forestry Association, at Washington, D. C., and a meeting of State foresters held under the auspices of the Forest Service. This meeting was called to confer on the coöperative fire protection under the Weeks Law.

On March 24, 1913, at Asheville, N. C., the Forester represented the North Carolina Geological and Economic Survey at a meeting of the directors of the American Forestry Association.

On November 17 to 20, 1913, at Washington, D. C., the Forester represented the North Carolina Geological and Economic Survey at the annual meeting of the National Conservation Congress. He was a member of the resolutions committee and was appointed a member of the forest fire committee.

The Forester of the Survey, as the member for the South of the Forest Fire Subcommittee of the National Conservation Congress, prepared and sent out to representative men in all the Southeastern States questions regarding forest-fire conditions in these States. As a result of this investigation a report was prepared by the Forester for the National Conservation Congress, and this has been incorporated in their printed report. This report is given below:

REPORT ON FOREST FIRE CONDITIONS IN THE SOUTHEASTERN STATES

To the Chairman, Forest Fire Subcommittee, National Conservation Congress, by J. S. Holmes.

THE REGION.

The region covered by this report includes the States of Delaware, Maryland, West Virginia, Kentucky, Missouri, Arkansas, the eastern half of Texas, and all of the States to the south and east of these. This region was originally almost entirely covered with forest, and though much of the land has now been cleared for agriculture, even yet 54 per cent of the total area is occupied by forest growth.

Forest.—Two general types of forest occupy the region: the southern pine forests extending along the Atlantic and Gulf coast, and the central hardwood forest occupying the northern and western parts of the region. A small area of spruce forest covering approximately a few hundred thousand acres in West Virginia and North Carolina is included in the hardwood forest. The two main types are about evenly divided, there being approximately 130,000,000 acres of each. According to the report of the National Conservation Commission, supplemented by some local data, 46 per cent of this forest land is owned by lumbermen and other large owners. The rest is held in small tracts by farmers and other residents.

In the States under consideration there is an estimated stand of a little more than 700,000,000 M feet of timber, something over half of which is pine. Placing the value of stumpage at five dollars a thousand, which lumbermen consider a conservative estimate, the present value of this stand is about $3,600,000,000.

Fire Damage.—Throughout this entire region, comprising sixteen States, only one, Maryland, has any complete data in regard to forest fires. Two other States, North Carolina and Louisiana, have some incomplete records, which are here used for what they are worth. The only complete figures for the remaining States were those collected in connection with the tenth census. It seems probable that while the area annually burned over is no less than given there, the damage done by fires is much greater, because the value of stumpage has so largely increased since that time. It appears, therefore, that there is an annual loss from forest fires throughout this region of $23,700,000. In this estimate only the loss in standing timber and other personal property is included. The loss through impoverishment of the soil, injury to stream flow, and change in the composition of the future forest would add enormously to this damage. There are no records of any loss of life in any of the Southern States except in North Carolina, but in all probability each fire season exacts its toll, even though our fires are supposed to be harmless.

PRESENT ATTITUDE OF THE PUBLIC.

The attitude of the general public towards forest fires is at present one of indifference. In a few States, however, the sentiment is against burning the woods, and throughout the region this sentiment is growing—in some States very rapidly. In Maryland "very few believe in burning"; in Virginia "the majority are interested in keeping out fires"; while in North Carolina landowners are anxious to prevent fires, especially in the hardwood region; in Louisiana "the people generally recognize the evil and do not favor burning the woods"; in the remaining States there seems to be little definite sentiment against the practice. Prof. Alfred Akerman well summarizes the general attitude of forest owners and users thus: That in pine woods burning improves pasturage, protects turpentine orchards, and does little or no harm; and in hardwood forests it improves pasturage and does little harm.

Lumbermen.—As a rule, lumbermen try to keep fires out until the timber is cut; after that no further effort is made, especially if they own only the stumpage. Taking the hardwood region as a whole, however, landowners would prevent fires if they could without any extra expense in the way of taxes or for patrol work.

Throughout the pine region the lumbermen rather favor fire because it keeps the woods open and so makes logging easier. As one lumberman expresses it, they "are only interested in long-leaf pine, and that is resistant to fire." In the loblolly pine woods where the injury done to the young growth by fire is so much more evident, some lumbermen favor fire prevention. As a class, however, the southern pine lumberman is indifferent to the fire problem. It is argued in support of this indifference that "annual grass fires are safer than accumulated forest-floor débris, which invites heavier conflagration."

A Florida lumberman, F. E. Waymer, president of the Union Lumber Company at Jacksonville, states the general attitude of forest owners thus: "Some think burning necessary in all timber and all agree that it is necessary in boxed timber." It is a common practice in turpentine orchards to burn over the area each winter as a protective measure in order to prevent devastating fires when the ground is dry and the turpentine is running. Very few, however, of the turpentine operators own the land, so they may be classed with the nonlandowning lumbermen and with the small farmers and tenants who own little or no land. In short, the attitude depends more upon whether the person owns land or not than upon any other one circumstance. This is true both in the pine and in the hardwood region, though the feeling against fires, as before stated, is decidedly less in the pine region.

Stockmen.—The small farmers and renters favor burning the woods where stock is allowed to run at large, and these conditions extend over nearly the whole of the southern pine region and the western part of the hardwood region. Stock owners burn the woods in order to make early grass more available to the cattle and also to kill out the undergrowth so that it will be easier to keep track of loose stock. As long as there is free and unrestricted range, there will be general trouble from fire, and possibly no measures would do more to prevent fires than the passage of general State-wide stock-law bills. It is a well known fact that the free ranging of live stock is a much smaller industry than would be lumbering if forests were allowed to grow on the open range area.

Railroads.—In speaking of the general attitude, that of the railroads might be mentioned. Though it would seem to be to their interest to assist in preventing fires, they are not only indifferent, but in some cases use all their influence to prevent the enactment of fire preventive laws; and until there is a much stronger public sentiment in favor of State fire protection the railroads will continue to exert their influence against such measures. Their excuse for this attitude is that though they are spending a large amount of money every year in damages for fires set by them, or said to have been set by them, still they do not know what the cost of preventive measures would be, and they are unwilling to undertake any unknown expense.

REASONS FOR PRESENT ATTITUDE.

What, then, are the principal reasons for the present attitude of indifference towards fires and its consequent ruinous effect on the present and future value of the forests?

(1) *The large amount of forest land in the South.* At the present time over half the total area of the region is in woods. On account of the small amount of immigration and the present tendency of the farmer to concentrate his efforts on less land, this will not change very rapidly.

(2) *The comparative immunity of mature timber from destruction by fires.* Only in turpentine orchards is there very serious danger of widespread destruction of large timber, and here operators contend that controlled burning is the surest method of protecting it. Under present conditions they are no doubt right.

(3) *The comparative low value of second-growth timber.* Up to within very recent years second-growth pine throughout most of this region has been looked upon as worthless material and as something to be destroyed or prevented from occupying the ground. This condition is rapidly changing, for even now in many parts of the region second-growth timber is the principal supply for the sawmills.

(4) *The free ranging of stock.* As a general thing, the stock that roams the open range does not belong to the owners of the land. In most of the open-range region the stock owners outnumber the landowners very considerably, so that the prospect for any rapid change in this direction is remote. The stock law is generally looked upon as a local question to be settled by the vote of the majority in each locality. There seems, therefore, little prospect of effective fire prevention until stock can be confined to the land of its owner.

(5) *The dread of increased taxation.* This feeling against taxation is as strong or stronger in the South than anywhere else, and, as fire protection is obliged to cost money, the need for such expenditures must be very real and very pressing before they are undertaken. The farmer would probably advocate State protection were it not for this fear of taxation. In many cases lumbermen already pay excessive taxes on standing timber and dread a raise in the tax rate. Mr. George K. Smith, secretary, Yellow Pine Manufacturers' Association, connects taxation with this problem in this way:

"The tax laws and interest rates make it unprofitable for any one to undertake to reforest a given area in the South, and while some efforts may be made to keep fires out of young timber, I do not believe there has been any organized effort along that line so far in the South."

The three following adverse influences would, it seems, help to account for lack of interest on the part of many lumbermen:

(6) *The tenure of timber without the land.* Nonlandowning lumbermen have no interest in preventing fires except to protect merchantable timber or other property connected with their operations. As soon as the timber is cut they have no further interest in the property, and, too often, none in the State in which they have worked.

(7) *The low prices paid for stumpage, or for land including stumpage.* no doubt, largely, though perhaps unconsciously, influence the lumberman. The present value of the stumpage alone is in most cases much more than was paid for the land and timber together. When the timber is removed it is felt that the remaining land and young growth, having cost less than nothing, is not valuable enough to spend money on for protection.

(8) In many cases the owner plans to sell off his cut-over land to settlers as rapidly as possible, and his only efforts are to secure purchasers for this land at remunerative prices. However, a large part of the cut-over pine lands will not be needed for agricultural purposes and cannot be sold for many years to come.

It seems a business proposition to encourage second growth, so that a second crop of timber might be secured while a market for the land is developing. The opinion is too prevalent among the timberland owners that reforestation means planting, and that it is an entirely separate and subsequent operation to lumbering. This is possibly the attitude of Mr. George K. Smith, secretary, Yellow Pine Manufacturers' Association, who courteously answered the inquiry sent to him. He says:

"In my judgment, the indifference shown by timberland owners and lumbermen in the South to the prevention of fire in the forest is on account of the fact that no systematic or definite effort has been made for reforestation. Until the time arrives when an attempt is made to reforest the cut-over lands, no one is particularly interested in the question of fire. As long as fires do not damage the standing timber of merchantable growth, it will be very difficult to arouse general interest in fire prevention."

Perhaps the most important as well as one of the most difficult problems before the advocates of fire protection in the South today is that of enlisting the active support of the lumbermen. In the Northwest, where associations of lumbermen are coöperating with the State and Federal authorities in fire prevention, the safety of the mature timber is at stake. In the South, on the other hand, the mature timber is comparatively resistant, but the young forest, the supply of the future, is menaced. Over nearly the whole of this region natural regeneration is practically assured if hogs are excluded, seed trees provided for (either before or after cutting), and fires are prevented. How can the landowners, farmers as well as lumbermen, be convinced that fire protection will pay them?

PRESENT STATUS.

Efforts have been and are being made along the lines of education and legislation in most of the States, though in most cases they have been lamentably feeble and ineffective. The number of professional foresters employed by the Southern States is not over five or six.

Education.—Some elementary forestry courses are given in a few of the State institutions of learning, but they are incidental to other courses and are in very few cases adequate to the needs. Only Maryland, Georgia, and possibly Missouri have such courses in charge of technically trained men. Several of the States have issued one or more publications on forestry subjects, in most cases based on work done in coöperation with the Federal Forest Service. The Federal Government has also done much to bring the question of forestry before the people of the various States through lectures and exhibits, and by making examinations of woodland properties for the owners. The results accomplished by this and other educational and propaganda work of the Government would be hard to overestimate.

Only two States, Maryland and Kentucky, employ as State Foresters technically trained men, though North Carolina employs a Forester in the State Geological and Economic Survey. In several States, notably Kentucky, West Virginia, and Louisiana, Arbor Day is observed in the public schools to a greater or less extent; but usually the observations are not general. No other method, so far as is known, has been employed to bring this subject to the attention of the children, though in North Carolina a forest-fire circular, adapted from one used in Pennsylvania, Massachusetts, and other States, is now being distributed to the public school children.

Legislation.—Forestry legislation is quite as inadequate as forestry education. Maryland has had an excellent law for several years, so she is really outside of this class. Louisiana and Kentucky have recently enacted laws carrying adequate appropriations and are now organizing work on an efficient scale. Tennessee, Alabama, and Delaware have enacted fairly good laws, but, through lack of interest in the subject, have failed to carry appropriations to make the laws effective. They are, therefore, practically dead letters. West Virginia would have passed an up-to-date law at the last session of its Legislature but for lack of time. It will undoubtedly enact one at the next general session. Efforts have been made to pass important forest laws in several other of the Southern States, but so far there has not been sufficient definite public opinion behind them to overcome the opposition of certain interests, chiefly the railroads and the nonlandowning stock men.

Private Effort.—No efforts have been made amongst landowners to organize for fire protection, though individual owners have in several States organized and carried out protective measures on their own lands. Two railroads operating in the northeastern part of the region, the Pennsylvania and the Baltimore and Ohio, are said to be attempting some measures of fire prevention along their lines. The former has constructed a few miles of fire line along their road in Maryland and Delaware, and have issued notices to their employees to take precautions to prevent fires. The latter road also instructs its section hands to extinguish fires. Engines on all the roads are said to be equipped with spark arresters, but there are no State or, as far as can be learned, railroad regulations, except in Maryland and West Virginia, to insure that these are kept in proper condition. As a matter of fact, railroads set a large percentage of forest fires.

Federal.—With the exception, then, of Maryland, the Federal Government is the only active organization preventing fires in this region. The National Forests in Florida and Arkansas have been patrolled for several years, and

organized protection has been started on the land recently acquired in Virginia, North Carolina, South Carolina, Georgia, West Virginia, and Tennessee, for the Southern Appalachian Forests. The total area now being protected by the Federal Government in this way is about 2,125,000 acres. This, together with the private property in the various States said to be patrolled by the owners, amounts to something like 3,250,000 acres or about 1¼ per cent of the total forest area of the region. Through the operation of the Weeks Law, the Federal Government offers to coöperate with the States in organizing State fire protection; but so far only two States, Maryland and Kentucky, have availed themselves of this offer.

Stock Law.—With the exception of Delaware, and possibly of South Carolina, all the States in the region are handicapped by having some at least of their territory not subject to the stock law. On such open-range territory live stock is allowed to roam at will over all unfenced lands. Maryland has only one free-range county, and Virginia only a comparatively small amount. In North Carolina only some of the far eastern and western counties, 12 to 15 per cent of the State, now have free range. A larger percentage of most of the other States are still without the benefits of the stock law. This law is usually a local option measure and spreads slowly by townships or counties voting for the stock law.

WHAT IS TO BE DONE?

The important measures necessary to bring about general fire protection throughout the South come under the heads of (1) Education; (2) Legislation; (3) Coöperation. Education will bring about the legislation, and education and legislation should aim to bring about the coöperation.

1. *Education.*—Publicity and propaganda work must be conducted throughout the South for many years to come, reaching not only the landowners and other adults, but also, and perhaps chiefly, the children of the public schools.

Federal.—The Federal Government has already in operation an excellent organization for carrying on propaganda work. Lectures, exhibits, and demonstrations are now being carried on. The Government should be allowed and urged to extend this work in every way possible. Miniature exhibits, if only of photographs, might be made at State and even county fairs; lectures might be given in connection with these exhibits, as has been done at some of the larger exhibits made. Lecture courses, illustrated when possible, now given at many summer schools, should be extended; they might even be made to include the teachers' institutes at which the public school teachers meet and study before dispersing to their various schools. The demonstration work now carried on in the National Forests should be extended to as many States and as many parts of States as is possible under the Weeks Law. The publications of the United States Department of Agriculture are many of them unexcelled for propaganda work, and they will be read more when the question of forestry has attracted the attention of the public from some other source as well.

State.—The various States should employ technically trained foresters, at first chiefly with the object of interesting people in this subject. A subsequent duty, and sometimes one long postponed, will be to organize and carry out actual protective work. The public schools are, of course, under direct control

of the States, and it is the State's duty in one way or another to bring this matter to the attention of the children. The general observance of Arbor Day should be insisted on, and some elementary instruction either in connection with botany or some other course, or as a special course, should be given in all schools. Lectures and addresses at schools and colleges, at public meetings, farmers' institutes, etc., should be given as often as opportunity offers. Demonstration forests should be purchased and administered by the State, but these will come later. As many State educational institutions as possible should teach forestry, not as a professional course, but as an auxiliary, aiming to train for their life work prospective landowners and lumbermen.

Association.—The organization of live forestry associations, or the formation of forestry divisions in already existing organizations, will be of great assistance. The appointment in our half-dozen large lumbermen's associations of forestry committees and the organization of forest protective departments, such as some of the northern associations have, should be advocated and worked for. The Farmers' Union and other similar organizations should be enlisted in this work. The farmers, as a class, are more concerned both personally and financially than any one else, and they should be the easiest class to reach. The women's clubs have in some States—Kentucky, for example—taken up this question earnestly, and done heroic work. Their active coöperation should be enlisted all over the country. They can, perhaps, do more to bring this question to the attention of the public school authorities than any other one force.

2. *Legislation.*—It is recognized that legislation is of little value unless public opinion is behind it. This is shown by the present condition of legislation in several of the States. However, the efforts to secure legislation, though they may be feeble and ineffective, do tend to educate public opinion and call the attention not only of legislators, but also of the people in general, to the question of fire prevention. All efforts at securing legislation must have some good effect. It is a general maxim in seeking legislation to "ask for what you want, but take all that you can get." This, however, may be modified in some cases by refraining from asking for one necessary measure of fire protection if certain interests—for instance, the railroads—will be antagonized. It might in certain cases be a better policy to try for what it seems possible to get, and, by arousing no organized opposition, succeed in securing it. Later, laws can remedy early defects.

Four general classes of legislation are needed throughout the South: (*a*) Laws to control the individual; (*b*) laws to regulate railroads and other corporations; (*c*) laws to secure the enforcement of the law; (*d*) appropriations to make them effective.

a. In North Carolina, which is, perhaps, fairly representative of the region, 45 per cent of forest fires are caused by carelessness or indifference of the individual, largely from farmers burning brush, rubbish, etc., and from hunters. It does not seem possible as yet to make and enforce any stringent laws requiring license for burning brush, though Maryland has such a law which works well. Laws against carelessness, and forbidding the leaving of any fire unextinguished, whether camp fire, brush, stumps, or what not, seem necessary and advisable all through the South.

Under this heading the stock law must again be referred to. Throughout the South this is a most important forest protective measure, not only because hogs are preventing the regeneration of most of our long-leaf pine forests, but because so many fires are set in order to "improve the range." As long as forest lands are looked upon by the resident and nonlandowning population as so much free pasture, the sentiment in favor of burning the woods will not greatly diminish. Every one interested in forest protection should preach State-wide stock law.

b. Railroads, sawmills, and other engines cause approximately one-third of the forest fires; the necessity, therefore, for laws to control the operators of such engines is obvious. Railroad corporations throughout the South, as in other parts of the country, are very powerful, so that unless public interest is aroused it will be difficult to secure the passage of laws which are obnoxious to them. On the other hand, it does not seem fair to the railroads to insist on their taking expensive precautions to prevent fires until the people are sufficiently alive to their own interests to do their share.

c. It is the experience throughout the South that general laws against fires cannot be enforced. The usual county and township officials are not interested in forest protection and do not receive sufficient compensation to secure the enforcement of these laws. In two or three States an attempt has been made to have the forest laws enforced through the State game warden system. This has also failed. A State system of fire wardens such as is in force in Maryland and many of the Northern and Western States seems the best method for the South. There is no need, for the present at least, to appoint wardens in all townships; but where the percentage of forest land is over 60 per cent there is need for organized fire protection.

d. No system of fire protection can be effective without an adequate appropriation. It is the general opinion that this should be made by the State, but it might well be added to by counties, townships, and associations of landowners. The proffered assistance of the Federal Government under the Weeks Law would not only be a great assistance, but is also a great incentive towards securing an appropriation. The operations of this Federal law should be continued and extended as much as possible.

3. *Coöperation.*—It is the general opinion that to make forest-fire protection most effective the coöperation of all available forces is necessary. Nearly all correspondents advocate State protection assisted by either the Federal Government or by associations; where possible, all three of these forces should be utilized, and, in addition, the counties and townships themselves might be brought into the coöperative scheme. The details of such an arrangement are being worked out in the Northern and Western States, and they will subsequently have to be worked out in the South. State protection should come first. Federal coöperation will thus be automatically secured in most of the States; then, under favorable State laws, the coöperation of associations should be secured. It will not be until all these forces work together, and are supported by public opinion, that real forest protection will be secured.

Forest Area, Timber Stand, and Forest Fire Conditions of the Southeastern States.

Prepared for Forest Fire Subcommittee of National Conservation Congress by J. S. HOLMES, 1913.

State.	Total Area, Acres.	Area of Forest Land.	Percentage of Forest Land.	Area of Forest Land Owned by—		Present Stand.		Area Patrolled by Private Owners.	Area in National Forests Under Protection.	Area Burnt Over Annually, Acres.	Value of Property Destroyed Annually.
				Lumbermen.	Farmers, Etc.	Timber, Million Bd. Ft.	Value.				
Delaware	*1,257,600	*350,000	*28	*119,000	*231,000	†300	$ †1,500,000	----------	----------	**4,687	$ †7,500
Maryland	*6,362,240	†2,000,000	†31	†500,000	†1,500,000	†3,500	†14,000,000	†10,000	----------	†40,000	†120,000
Virginia	*25,767,680	†15,000,000	†54	†5,000,000	†10,000,000	†30,000	†150,000,000	†50,000	‡‡212,796	**234,375	†375,000
North Carolina	*31,193,600	*19,600,000	*63	†5,600,000	†14,000,000	†55,000	†165,000,000	‡250,000	‡‡95,459	†440,000	†660,000
South Carolina	*19,516,800	†13,741,000	†61	†5,532,000	†8,209,000	‡30,700	‡153,500,000	----------	‡‡21,376	=431,730	††1,226,113
Georgia	*37,584,000	*22,300,000	*59	*6,480,000	*15,820,000	‡46,000	‡230,000,000	some	‡‡64,889	=705,351	††2,003,197
Alabama	*32,818,560	*20,000,000	*61	*11,200,000	*8,800,000	‡56,300	‡281,500,000	‡‡40,000	----------	=569,160	††1,616,414
Florida	*35,111,040	*20,000,000	*57	*16,600,000	*3,400,000	‡73,900	‡369,500,000	----------	‡‡318,960	=105,320	††299,109
Mississippi	*29,671,680	*17,500,000	*59	*8,400,000	*9,100,000	‡95,300	‡476,500,000	----------	----------	=222,800	††632,752
Louisiana	*29,061,760	†22,000,000	†76	†15,000,000	†7,000,000	†100,000	†500,000,000	†60,000	----------	†2,000,000	†5,000,000
Texas (Eastern half)	*83,967,360	*30,000,000	*36	*12,000,000	*18,000,000	‡66,000	‡330,000,000	----------	----------	=599,359	††1,702,180
West Virginia	*15,374,080	†9,500,000	†62	†4,500,000	†5,000,000	†30,000	†150,000,000	†500,000	‡‡54,598	†629,526	†1,018,144
Kentucky	*27,715,840	†9,416,000	†34	*2,600,000	*7,400,000	†24,000	†48,000,000	‡‡100,000	----------	=556,647	††1,580,877
Tennessee	*26,679,680	*15,000,000	*56	*4,200,000	*10,800,000	†26,000	†52,000,000	‡‡150,000	‡‡173,101	=985,430	††2,798,621
Arkansas	*33,616,000	*24,200,000	*72	*13,550,000	*10,650,000	‡78,700	‡393,500,000	----------	‡‡1,184,012	=858,115	††2,437,047
Missouri	*43,985,280	*18,300,000	*42	*8,050,000	*10,250,000	‡9,900	‡49,500,000	----------	----------	=783,646	††2,225,555
Totals	479,683,200	258,907,000	54	119,331,000 (46%)	140,160,000 (54%)	725,600	3,364,500,000	1,160,000	2,125,191	9,166,146	23,702,509

*From Report of National Conservation Commission, 1909.
†From local sources.
‡From "The Lumber Industry" report of Bureau of Corporations, 1913.
Valued at $5 per thousand.
=From census of 1880, for that year.
**Average damage per acre of N. C., $1.57; W. Va., $1.62.
††Average damage per acre of three latest years of Md., N. C., La., and W. Va. records, *i. e.*, $2.84 per acre.
‡‡Estimate of U. S. Forest Service.

WORK OF UNITED STATES FOREST SERVICE IN NORTH CAROLINA.

The United States Forest Service has not only coöperated very cordially with the State Survey in various lines of forestry work in the State, but has also been very actively engaged in other lines of work in different parts of the State.

Its chief work has been carried on either in connection with the acquisition of lands under the Weeks Law or the administration of lands already acquired under this law.

APPALACHIAN FOREST RESERVE.

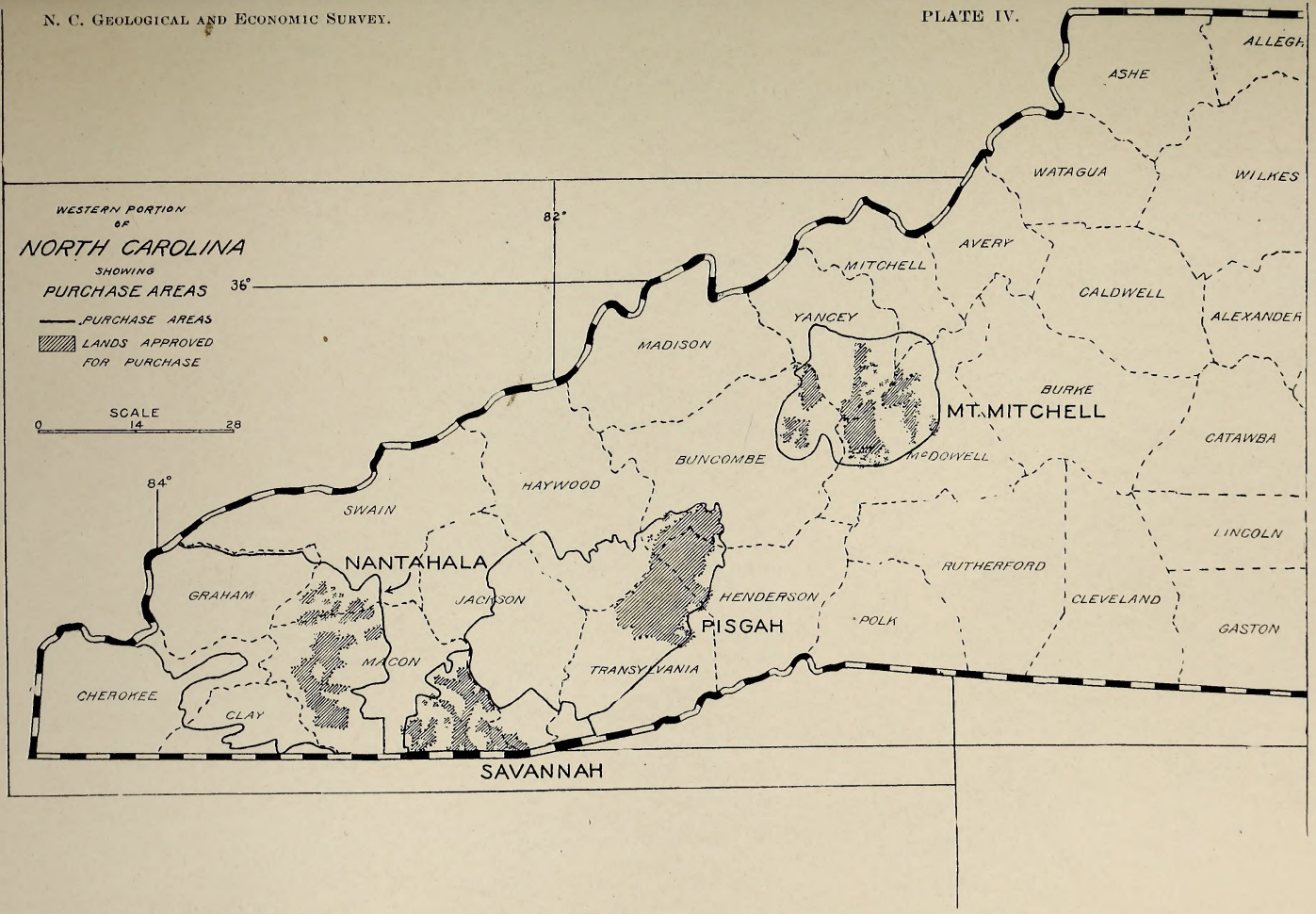
During the years 1913 and 1914, 170,709 acres were approved for purchase. This brings the total amount of lands approved for purchase up to 224,694 acres. These lands are located as follows: 66,213 acres on the Mount Mitchell purchase area; 36,973 acres on the Nantahala area; 86,700 acres on the Pisgah area, and 34,808 acres on the Savannah area. Since the available balance under the Weeks Law is now small, it will be possible to purchase only a small additional acreage until the appropriation shall be extended.

The entire acreage which has been approved for purchase is being protected from fire. During the year 1914 permits were issued for the grazing of 1,950 head of cattle, 500 sheep, and 4,630 hogs on lands which have been acquired. Small timber sales are being made from some of the tracts, titles to which have passed to the Government. The cutting is so regulated as not to injure, but rather to improve, the condition of the forest.

There is given in Plate IV a map showing the location of the land approved for purchase for National forests and also the location of the land already within these areas.*

A mill-scale study was made at High Point to determine the amounts of veneer cut from different size oak and yellow poplar logs. The production of lumber in North Carolina for both the years 1913 and 1914 was ascertained in connection with that from other States. Information is at present being secured as to the size and class of lumber manufactured at different plants which will be used in the compilation of a general bulletin for the information of lumber consumers. The studies of the cooperage and box industries and the measurement of yellow pine timber for the purpose of determining its density for the preparation of grading rules are general studies which extended to North Carolina. There was made at Wilmington a test of the distillation of western yellow pine on a semicommercial scale.

*This map was prepared for the State Survey by the United States Forest Service.


WESTERN PORTION
OF
NORTH CAROLINA
SHOWING
PURCHASE AREAS
PURCHASE AREAS
LANDS APPROVED
FOR PURCHASE
SCALE
0 14 28
82°
36°
84°
ALLEGH.
ASHE
WATAGUA
WILKES
AVERY
MITCHELL
YANCEY
CALDWELL
ALEXANDER
MADISON
BURKE
MT. MITCHELL
CATAWBA
BUNCOMBE
McDOWELL
HAYWOOD
SWAIN
LINCOLN
NANTAHALA
RUTHERFORD
GRAHAM
JACKSON
HENDERSON
PISGAH
POLK
CLEVELAND
GASTON
MACON
TRANSYLVANIA
CHEROKEE
CLAY
SAVANNAH

There is given below the allotment and expenditures by the United States Forest Service in coöperation with the States under the Weeks Law:

State.	Allotments, Calendar Year 1914.	Expenditures, Fiscal Year 1914.	Total Expenditures, Mar. 1, 1911, to June 30, 1914.
Maine	$ 10,000.00	$ 6,698.75	$ 27,093.22
New Hampshire	8,000.00	7,109.00	24,018.40
Vermont	2,500.00	1,541.95	5,218.35
Massachusetts	2,500.00	2,907.50	6,649.50
Connecticut	2,000.00	711.00	2,064.25
New York	10,000.00	5,647.07	13,287.07
New Jersey	2,000.00	2,220.00	5,326.33
Maryland	2,000.00	1,528.92	3,007.42
West Virginia	5,000.00	1,796.00	1,796.00
Kentucky	4,000.00	3,253.23	3,253.23
Michigan	5,000.00	.50	.50
Wisconsin	5,000.00	3,476.25	13,187.00
Minnesota	10,000.00	8,992.00	33,069.15
South Dakota	450.00	499.50	499.50
Montana	3,500.00	3,689.66	3,717.16
Idaho	7,000.00	5,778.69	6,937.89
Washington	10,000.00	5,243.25	8,062.00
Oregon	10,000.00	8,697.00	19,422.50
Inspection		1,290.16	1,290.16
Totals	98,950.00	71,081.33	177,899.63

TIMBER TESTS.

Other work of interest to the people of North Carolina that has been taken up by the United States Forest Service during the past two years has been certain tests relating to timber in regard to its strength, its preservation, its use in the production of pulp distillation of certain hardwoods.

Strength of Timber.

A study as to the effect of defects on the strength of the southern pines has been made, and is fast becoming the basis of the grading rules for all southern yellow-pine structural timbers.

Although no tests were made upon timber actually cut in North Carolina, yet some twenty-five species from just over the line, in the adjoining States of South Carolina and Tennessee, were tested, and these tests give comparable data on practically all species grown in North Carolina.

Preservation of Timber.

An investigation has been made as to the method of creosoting posts of various woods and testing the durability of the treated material.

Posts made of the following species were tested: Short-leaf pine, pitch or old-field pine, post oak, red oak, tulip tree, black-gum, sweet-gum, and hickory; and short-leaf pine shingles. It was demonstrated that all the species mentioned could be creosoted by the open-tank process. Investigations were made from time to time in regard to durability of the treated posts and shingles. The results up to January, 1915, are as follows:

Timber Suitable to Produce Pulp.

Loblolly pine and black-gum have been tested by the mechanical process, and it was found that both woods could be used in this process to produce pulp for certain products, such as board, cheap wrapping paper, etc., where color and finish are of minor importance.

Scrub pine, sand pine, loblolly pine, cotton gum and red gum were tested by the sulphite process, and all were found capable of reduction. The first three produced fairly long-fibered pulps, suitable to be used in the production of medium wrapping paper and cheap newspaper. The last two were short-fibered, but easily bleached, and could be used, by the admixture of pulp from some coniferous wood, in the manufacture of cheap book paper.

Long-leaf pine, loblolly pine, scrub pine, sand pine, cotton gum and red gum were tested by the soda process. The four conifers produced a brown pulp, admirably adapted to the manufacture of high-grade wrapping paper, such as kraft. The first two were exceptionally long-fibered and suitable for this use. The two gums produced short-fibered, but easily bleached, pulps of considerable bulk, which were admirably adapted to the manufacture of book paper of good quality when used in conjunction with easily bleached sulphite pulp from some conifers, such as spruce.

A large amount of work has been devoted to the sulphate process, especially when used with long-leaf pine, and it has been found that this wood is capable of reduction by this process to an exceptionally long-fibered, strong pulp of great wearing qualities and suitable for the manufacture of high-grade wrappings, such as kraft. From the behavior of this process on long-leaf pine it is evident that short-leaf, loblolly, scrub, and any other of the resinous southern pines can be readily reduced to pulp suitable for this use.

Distillation of Certain Woods.

Experiments have been made on the yields from the destructive distillation of certain hardwoods, and the following species, indigenous to North Carolina, were tested: beech, birch, chestnut, hickory, maple, red

gum, tupelo, white elm, and white oak. A report has been published on this investigation in Bulletin No. 129 of the publications of the United States Department of Agriculture.

Another investigation was on the "Distillation of resinous woods by saturated steam," which included the yields and the products of the steam distillation of long-leaf pine. The results of this investigation have been published in Bulletin No. 109 of the Forest Service, United States Department of Agriculture.

In the study that has been made by A. W. Schorger on the "oils of the coniferæ," the leaf oil of long-leaf pine has been investigated both as to yields from the tree and the chemical composition of the oil.

The short-leaf pine has been studied as to its suitability as a raw material for the production of ethyl alcohol.

Drying Certain Woods.

Experiments were conducted in regard to drying and transforming the following species: red gum, white oak, hickory, maple, birch, cucumber, dogwood, and ash.

Special assistance in regard to this subject was given to the Bryson City Pump Works, Bryson City, Swain County, in regard to drying pine pump sections;

To the Pisgah Hardwood Company, Pisgah Forest, Transylvania County, information was given regarding dogwood;

To the High Point Furniture Company, High Point, Guilford County, information was given regarding the drying of red gum.

NORTH CAROLINA FORESTRY ASSOCIATION.

The State Survey has coöperated with the North Carolina Forestry Association in every way possible during the past two years to arouse the people of the State to a fuller realization of the need of the conservation of our forests.

The work of the association is almost entirely educational, and in assisting it the State Survey is enabled to carry out one of its principal objects much more effectively.

At the present time Mr. Hugh MacRae, one of the members of the Geological Board, is president of the North Carolina Forestry Association, and Mr. J. S. Holmes, Forester of the Survey, is its secretary. Mr. Holmes has held this position ever since the organization of the association.

The State Geologist and the Forester have assisted in the arrangements for the various meetings of the association and have attended all of them.

On January 16, 1913, the third annual convention of the North Carolina Forestry Association was held in the Chamber of Commerce rooms in Raleigh, and about eighty delegates registered. Considerable interest was shown in the various forestry problems that came up and there was a general discussion of nearly all of them.

The following resolutions were adopted by the Association:

1. Federal Coöperation in Forest Fire Protection.

Whereas the Congress of the United States, in the passage of the Weeks Law, recognized the duty of the Federal Government in protecting the headwaters of navigable streams by preserving the forests at their sources; and

Whereas, under the terms of the aforementioned Weeks Law, the Federal Government is willing and anxious to coöperate with the State of North Carolina in protecting from fire the forests of the mountain and Piedmont regions of our State; and

Whereas it appears that the fund at the disposal of the Federal Forest Service is insufficient to continue this offer of coöperation for more than the present year: Now, therefore. be it

Resolved, That the North Carolina delegation in Congress be asked to obtain, if possible, an additional appropriation to be expended under the terms of the Weeks Law in the protection of forested watersheds at the headwaters of navigable streams.

2. National Forests.

Whereas there seems to be a strong movement in Congress to turn over to the various States the National forests within their borders; and

Whereas the present policy of creating National forests in the Southern Appalachians is calculated to be of great and lasting benefit to our people and industries; and

Whereas the reversal of the present Federal forest reserve policy would be a serious backward step and would mean a great loss not only to the Nation at large, but to our own State: be it

Resolved, That the Senators and Representatives of North Carolina in Congress be asked to use every effort in their power to defeat this threatened movement to turn the National forests over to the States.

3. State Protection of Forests from Fire.

Realizing that nearly two-thirds of this State is covered with forest growth, and that this timber crop is growing less than half as fast as it is being cut, and that this annual yield from our forest land could be largely increased were forest fires prevented; and

Whereas the loss from forest fires in North Carolina averages four thousand dollars per day throughout the State; and

Whereas this loss could in large part be prevented by a State fire warden system: Therefore, be it

Resolved, That we hereby declare ourselves as heartily in favor of State protection for our forests, and do strongly urge upon the General Assembly

now in session the passage of the act drawn by the legislative committee of our association, providing for an adequate forest-fire law, with a sufficient appropriation to make it effective.

4. State Protection from Loose Stock.

Whereas loose hogs and cattle are preventing the reforesting with long-leaf pine of vast areas of cut-over forest land in the eastern half of North Carolina; and

Whereas many of the fires in eastern North Carolina are the result of running live stock on the open range; and

Whereas an enormous economic loss to the State from this cause can only be prevented by protecting such areas from hogs and cattle: be it

Resolved, That we heartily indorse the movement to extend the stock law all over the State; and do respectfully request the General Assembly to pass a State-wide stock law.

5. Arbor and Bird Day.

Whereas a more intelligent appreciation of the value of our trees and forests, and also of our beneficial birds, is sadly needed among all classes of the community; and

Whereas any widespread and permanent improvement in this regard must begin with the younger generation; and

Whereas Arbor Day is now observed in the public schools of at least three-quarters of the States of the Union: Therefore, be it

Resolved, That we strongly recommend that the General Assembly pass a law requiring the observance of an Arbor and Bird Day in the public schools of the State.

6. Mount Mitchell Forest Park.

Whereas Mount Mitchell has exceptional interest to all North Carolinians, in that it is the highest peak east of the Mississippi River and it is the scene of the death and the grave of one of Carolina's distinguished sons, Prof. Elisha Mitchell; and

Whereas it is meet that the State should honor the memory of Professor Mitchell in this way: be it

Resolved, That we urge the Legislature to pass a bill to make a State park and demonstration forest area including the top of Mount Mitchell.

At a special meeting of the executive committee of the North Carolina Forestry Association, held in Raleigh on September 30, 1913, which was attended by the Forester, a resolution was passed requesting the Council of State to plant a collection of North Carolina trees on the Capitol grounds, and also on the grounds of the Governor's Mansion.

Arrangements for the fourth annual convention of the North Carolina Forestry Association, which was held in Asheville June 10 and 11, 1914, were largely made by the Forester of the Survey. The State Geologist presided at the sessions of the convention and made a short address on *A Forest Policy for North Carolina.*

The following resolutions were passed by the Association:

1. State Forestry Legislation.

Whereas the North Carolina Forestry Association, assembled in Asheville, N. C., in this their fourth annual session, believe that a great waste of timber throughout the whole State of North Carolina is going on through forest fires, diseases, lumbering, and woodworking plants of all kinds, and that this waste, with a comparatively small cost, can be reduced to a large extent and to the benefit of the whole State: Therefore, be it

Resolved, (*a*) That we as an association recommend and urge the enactment of a State forestry law at the hands of our next Legislature that will remedy and stop waste by forest fires, etc., and that proper means for the enforcement of such law be provided.

(*b*) That the president of our association appoint a committee of not less than five members, to be known as a legislative committee, whose duty it shall be to draft such laws as they deem best fitted to cover the conditions that now exist in our State, and that such committee present or cause to be presented such laws to our next Legislature and urge their enactment.

(*c*) That it is the sense of this meeting that a sum of not less than $10,000 per annum should be appropriated by our State for the inauguration and carrying on of this great work.

(*d*) That the address delivered before this meeting by Dr. Joseph Hyde Pratt, acting president of this association, and the report of Secretary J. S. Holmes be commended to the legislative committee as embodying many helpful suggestions.

2. Stock Law Should be State-wide.

Whereas the indiscriminate ranging of stock through the open lands of both eastern and western North Carolina is a menace to the perpetuation of the forests of these regions through the destruction of the seed and young growth by stock, and because many of the forest fires indirectly result from this ranging: be it

Resolved, That the North Carolina Forestry Association heartily indorses the extension of the stock law, and believes that the operation of this law should be State-wide.

3. Forestry Work of the State Geological and Economic Survey.

Whereas the North Carolina Geological and Economic Survey has been commissioned by the Legislature to make investigations and recommend plans to the people and the Legislature for the improvement of the forest conditions of the State; and

Whereas the Survey has done and is doing as much as possible in this way with the limited amount of money at its disposal: Therefore, be it

Resolved, That the North Carolina Forestry Association do indorse the work of the Survey, and do hereby show its appreciation of the assistance the Survey has given to this association.

5. Death of Mr. George W. Vanderbilt.

Whereas the late Mr. George W. Vanderbilt was the first person in the United States to inaugurate systematic forestry practice; and

Whereas the fine example of forestry on the Biltmore estate remains as a permanent memorial to his memory:

Resolved, That this association laments the untimely removal from among us of the late Mr. George W. Vanderbilt; and

Resolved further, That a copy of these resolutions be sent to Mrs. Vanderbilt and to the American Forestry Magazine.

6. Appreciation of Mrs. Vanderbilt's Public Service.

Whereas Pisgah Forest, having been approved for purchase under the Weeks Law through the generous offer of Mrs. George W. Vanderbilt; and

Whereas Mrs. Vanderbilt has thus made it possible for the National Government to perpetuate the full use of this beautiful forest to the public for recreation and pleasure, as well as the use of its other natural resources: Therefore, be it

Resolved, That the State Forestry Association of North Carolina and the Appalachian Park Association in joint meeting hereby extend a vote of thanks to Mrs. Vanderbilt for her generous and practical coöperation in the work of National conservation.

FORESTRY EXHIBIT.

In connection with the State's exhibit at the National Conservation Exposition, which was held at Knoxville, Tennessee, during September and October, 1913, there was a special forestry exhibit which was installed by the Forester. Besides showing the maps and publications of the Survey, relating to forestry, there was an interesting exhibit from the Biltmore estate showing the growth of planted white pine. The Butters Lumber Company, of Boardman, Columbus County, assisted by exhibiting samples of red and white gum that had been worked up in various forms of interior finish. The Asheville Board of Trade also contributed to the State's exhibit by sending some photographs of the State's watershed, which illustrated the advantage of a forested watershed for a city's water supply. One of the most attractive exhibits in connection with forestry was that of the Champion Fiber Company, of Canton, who had a large and most interesting exhibit of their different products in their various stages of manufacture. This exhibit was installed by the company.

A small forestry exhibit was made at the State Fair in 1913.

For a more detailed description of these exhibits, see under "Exhibits at Expositions and State Fairs."

SUGGESTED FORESTRY LEGISLATION.

As will be seen from what has been stated regarding the forestry work in North Carolina and the resolutions passed by the Forestry Association, it must be granted that there is urgent need in North Carolina of legislation that will adequately protect and conserve the forests of this State for future generations. While it is realized that all desired results cannot be accomplished at once, yet a definite start can be made in regard to forestry legislation that will in time insure to the State adequate protection and practical conservation.

The State Geologist, therefore, submits to the members of the General Assembly of 1915, for their serious consideration, the following forestry legislation, which he strongly recommends should be enacted into law:

A BILL TO BE ENTITLED AN ACT TO PROMOTE THE FOREST INTERESTS OF THE STATE.

SECTION 1. That the State Geological Board through the Forestry Division of the State Geological and Economic Survey, shall take such action as may be deemed necessary by said board to prevent and extinguish forest fires; shall enforce all laws pertaining to the protection of forests and woodlands, and prosecute for any violation of such laws; collect data relative to forest conditions; and coöperate with landowners as described in section 2 of this act.

SEC. 2. That the Geological Board shall, whenever it deems it essential to the best interests of the people of the State, coöperate with counties, towns, corporations, or individuals, in preparing plans for the protection, management, and replacement of trees, wood-lots, and timber tracts, under an agreement that the parties obtaining such assistance pay at least the field expenses of the men employed in preparing said plans.

SEC. 3. That the Governor of the State is authorized, upon recommendation of the Geological Board, to accept gifts of land to the State, same to be held, protected, and administered by said board as State forests, and to be used so as to demonstrate the practical utility of timber culture and water conservation, and as refuges for game. Such gifts must be absolute except for the reservation of all mineral and mining rights over and under said lands, and a stipulation that they shall be administered as State forests. The State Geological Board shall have the power to purchase lands in the name of the State, suitable chiefly for the production of timber, as State forests, using for such purposes any special appropriations. The Attorney-General of the State is directed to see that all deeds to the State of land mentioned in this section are properly executed before the gift is accepted or payment of the purchase money is made. Said State forests shall be subject to county taxes assessed on the same basis as are private lands, to be paid out of any moneys in the State Treasury not otherwise appropriated.

SEC. 4. That all moneys received from the sale of wood, timber, minerals, or other products from the State forests shall be paid into the State Treasury

and to the credit of the Geological Board; and the moneys shall be expended for purposes of forestry in general, under the direction of the Geological Board.

SEC. 5. That for the purpose of carrying out the provisions of this act, and for forest-fire protection, there is hereby appropriated the sum of ten thousand dollars ($10,000) annually out of any moneys in the State Treasury not otherwise appropriated, to be drawn upon as directed by the Geological Board.

SEC. 6. That the Geological Board may expend annually out of the appropriation for its use a sum not exceeding five thousand dollars ($5,000), to be used in coöperative work with the Federal Forest Service under such terms as the said board may deem advantageous to the State, provided a like sum is expended for said purpose by said Service.

SEC. 7. That all laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 8. That this act shall be in force from and after its ratification.

HYDROGRAPHY.

STREAM GAUGING STATIONS.

On account of lack of funds it has been impossible for the Geological Survey to coöperate with the United States Geological Survey in the maintenance of gauging stations on the several streams of the State. For many years there was close coöperation between the two Surveys in this work, and formerly there were thirty gauging stations maintained in North Carolina by the Federal and State Surveys. The statistics relating to the information obtained by these stations are published in Bulletins 8 and 20.

During the past five years several gauging stations have been maintained partly by the United States Geological Survey and other Federal bureaus and partly by private parties.

During the year ending June 30, 1913, there were ten stations maintained in the State—three by the United States Geological Survey, two by the Weather Bureau, and five by private persons.

During the fiscal year ending June 30, 1914, there were twelve stations maintained—two by the United States Geological Survey, two by other Federal bureaus, and nine by private persons.

The results of the readings and measurements by these gauging stations for the past five years will be published as an appendix to Bulletin 20.

During the latter part of 1914 the Bureau of Drainage Investigations of the United States Department of Agriculture has established several gauging stations on the canals that carry the water in connection with the drainage of the swamp and overflowed lands of the State. At these

stations will be obtained information that will be of very great interest and value in regard to the run-off of water from these areas.

Continuous stream-flow records were obtained at the following gauging stations in North Carolina during the period December 1, 1912, to November 30, 1914:

Roanoke River at Old Gaston,
Yadkin River near Salisbury,
South Fork New River near Crumpler,
North Fork New River near Crumpler,
French Broad River at Asheville,
Little Tennessee River at Judson,
Tuckaseegee River at Bryson.

The following stations were established or reëstablished during the period:

Yadkin River near Donnaha, established April 11, 1913.

Hiawassee River at Murphy, discontinued December 31, 1913; reestablished January 14, 1914.

Nottely River near Ranger, reëstablished January 22, 1914.

Valley River near Tomotla, reëstablished January 21, 1914.

SWAMP LANDS AND DRAINAGE.

The question of the reclamation of the swamp and overflowed lands of North Carolina is not a new one, but it is only within the past six years that any positive results could be obtained.

There were formerly three obstacles that stood in the way of the successful reclamation of these lands:

1. Lack of machinery capable of digging suitable ditches or canals to take care of the water.

2. No adequate laws that would permit the carrying out of drainage propositions.

3. The excessive cost of clearing the swamp areas.

With the passage of the North Carolina Drainage Law in 1909 the last of these obstacles has been removed, and wherever the land has a sufficient agricultural value to warrant drainage, the drainage proposition can be carried out. In 1908 a careful estimate showed that there were within the State about 2,800,000 acres of unreclaimed wet and swamp lands. These lands constituted the most fertile within its boundaries. In the swamps of the Coastal Plain, and in the river valleys in the Piedmont section, these lands lay dormant and unprofitable. Their only recognized value consisted in the growing timber which they

contained, a large part of which had been removed. Much of this area was formerly owned by the State and by the State Board of Education, and had been sold to individuals and corporations at a low value, the purchasers having no other immediate purpose than the removal of the timber thereon. It was also estimated that at least 1,250,000 acres of these unreclaimed lowlands were susceptible of drainage at a reasonable cost, and the greater part thereof could be drained by gravity.

This did not comprise, by any means, all the lands where drainage was demanded. Many acres of the most productive lands were reclaimed years ago and cultivated for generations, but were unsatisfactory in their productiveness. In every year of excessive rainfall the growing crops were impaired, their productiveness greatly diminished. How often has the statement been heard, that the early season promised good crops, but the excessive rains in the midsummer "drowned them out"? Farming on such lands in the face of such unsatisfactory conditions was of necessity unprofitable.

Must the wet cultivated lands, estimated to contain in the aggregate about 6,000,000 acres, continue to be cultivated with failure or partial failure of crops every two or three years? All of these lands could be successfully drained so as to insure abundant yields every recurring year. There are no engineering problems which have not been solved, and the cost of such drainage was within the limits of economical investment and would yield abundant returns; there was one phase of the problem, however, involved in the successful drainage of these areas. It had come to be recognized that the problem was beyond the capacity of the individual landowner. The tract of land which can be successfully drained without reference to contiguous lands is very rare; and generally the drainage of one tract is connected with and dependent upon the drainage of other tracts. The dominant landowner must of necessity seek his outlet for drainage through the servient lands, and the latter must take care of the water which flows from the dominant land. It was recognized that only large areas could be successfully and economically drained, and that the burden must be distributed among all the landowners in proportion as the lands were benefited. This called for an adequate drainage law, which we now have.

It is gratifying to know that the basic and essential provisions of this law have been upheld and approved by the Supreme Court of the State. This test of the law has not only relieved the apprehension of skeptics, but has satisfied prospective purchasers as to the validity of the bonds issued by the drainage districts.

The reclamation and effective drainage of wet lands are not the only good results obtained by this drainage movement; but there are at least two public purposes to be subserved by drainage which further serve to emphasize its importance. The conservation of the public health is now occupying in a marked degree the attention of the medical man and the layman everywhere. Drainage will eliminate mosquitoes and other insects which propagate disease, will banish malaria, and add to individual efficiency. Again, one of the conspicuous current movements is that seeking to provide better highways. Drainage of swamp lands will mean a system of good highways traversing an area that was formerly impassable and often separated two sections of a county.

The cost of draining the swamp lands of eastern North Carolina varies from $4 to $6 per acre, while the drainage of the overflowed areas of the Piedmont section will vary from $15 to $20 or more per acre. In every instance, however, where a drainage district has been organized and the drainage work completed, most gratifying and satisfactory results have been obtained which have converted nearly all the people in the district to drainage enthusiasts.

There are now eighty districts organized or in the process of organization. Many of these are completed and crops are now growing where a few years ago there was nothing but swamps and mosquitoes.

The table below gives a list of the districts, their approximate acreage, and present condition:

Drainage Districts in Swamp Areas.

Name of District.	County.	Number of Acres.	Progress of District.
Broad Creek Drainage District	Beaufort	23,000	Completed.
Conaby Creek Drainage District	Beaufort	27,000	Organized.
Pantego Drainage District	Beaufort-Hyde	30,000	Completed.
Pungo River Drainage District, No. 1	Beaufort	27,000	Organized.
Buckle Swamp Drainage District	Bladen	1,222	Reported completed. Bonds not yet sold.
Turnbull Swamp Drainage District	Bladen	3,000	Petitioned for. (Had not been organized in 1912.)
White Oak-Buckle Swamp Drainage and Levee District.	Bladen		Organized.
Lyon Swamp Drainage and Levee District	Bladen-Pender	18,000	Completed.
Old Rice Lands (Orton Plantation)	Brunswick	17,400	Petitioned for (1912).
Camden Run Drainage District	Camden-Currituck	24,000	Completed.
Run Swamp Drainage District	Camden-Currituck	18,000	Petitioned for (1911).
Bear Swamp Drainage District	Chowan	5,000	Completed.
Bogue Swamp Drainage District	Columbus		
Chadbourn Drainage District	Columbus	7,300	Completed.
Columbus County Drainage District, No. 2	Columbus		Establishment of this district is completed.

Drainage Districts in Swamp Areas—Continued.

Name of District.	County.	Number of Acres.	Progress of District.
Clay, Red Swamp, and Swift Creek Drainage District.	Craven		Petitioned for, 1911. (Nothing further heard.)
Dover Drainage District	Craven	9,000	Completed.
Moseley Creek Drainage District	Craven	10,000	Organized and at work (1912).
Flea Hill Drainage District	Cumberland	20,425	Final report made; commissioners appointed; contract let.
Suggs Creek Drainage District	Cumberland	3,000	Petitioned for.
Moyock Drainage District, No. 1	Currituck	14,000	Completed.
Maxwell, Elder, and Stockinghead Drainage District.	Duplin	2,500	Petitioned for.
Muddy Creek Drainage District	Duplin	1,700	Work stopped.
Deep Creek Drainage District, No. 1	Edgecombe-Halifax	6,300	Petitioned for (1912).
Beaver Dam Drainage District	Harnett	7,500	Completed.
Stewart's Creek Drainage District	Harnett	7,000	Contract let.
Juniper Bay Drainage District	Hyde	7,000	Completed.
Mattamuskeet Lake Drainage District	Hyde	120,000	Organized. Dredges at work.
Abandoned Rice Lands	New Hanover	414	Petitioned for.
New Hanover County Drainage District, No. 1.	New Hanover	2,500	
Palmetto Drainage District, No. 1	Pamlico	54,000	Contract let.
Angola Bay Drainage District	Pender	14,700	Petitioned for.
Rocky Point Drainage District	Pender	7,000	All reports filed, and work now going on.
Parkville Drainage District, No. 1	Perquimans	5,400	Work begun. Final report made. Bonds for sale.
Back Swamp and Jacob Swamp Drainage District.	Robeson	35,000	Completed.
Hog Swamp Drainage District	Rockingham	15,000	Abandoned.
Little Coharie Drainage District	Sampson	3,300	Completed.
Ridder's Creek District	Tyrrell		Completed.
Lake Phelps Drainage District	Washington-Tyrrell	75,000	Final report filed.
Drainage District, No. 4	Washington		Petitioned for.
Pungo River Drainage District	Washington	20,000	Completed.
Wayne County Drainage District, No. 1	Wayne-Greene-Lenoir	3,000	Completed.
Wayne County Drainage District, No. 2	Wayne		Being organized.
Wayne County Drainage District, No. 3	Wayne		Being organized.
Toisnot Creek Drainage District	Wilson	2,200	Completed.
Wilson County Drainage District, No. 2	Wilson		Petitioned for.

As stated above, the North Carolina Drainage Law is just as applicable to the drainage of overflowed land in the Piedmont section of the State, and the following thirty-four districts have been organized or are in the process of organization:

Drainage Districts in Overflowed Areas.

Name of District.	County.	Number of Acres.	Progress of District.
Brown Creek Drainage District	Anson	7,500	Petitioned for.
Silver Creek Drainage District	Burke	1,400	Petitioned for.
Big Cold Water Creek Drainage District, No. 1.	Cabarrus	1,100	Completed.
Coddle Creek Drainage District	Cabarrus	1,200	Just organized.
Irish Buffalo Creek Drainage District	Cabarrus	1,375	Completed.
Lower Creek Drainage District	Caldwell-Burke	3,000	Contract let.
Lyles Creek Drainage Commission	Catawba		Work begun.
McLinn's Creek, No. 1	Catawba		Information from press clippings.
McLinn's Creek, No. 2	Catawba		Information from press clippings.
Pinch Gut Creek Drainage District	Catawba		Information from press clippings.
Buffalo Creek Drainage District, No. 1	Cleveland	14,611	Final report made.
Arcadia Township Drainage Commission	Davidson		Organized.
Middle Fork of Muddy Creek Drainage District.	Forsyth	550	Completed.
Muddy Creek District	Forsyth		Petitioned for.
Muddy Creek and Mill Creek Drainage District.	Forsyth-Davidson		Completed.
South Prong of South Fork Creek	Forsyth	175	Just organized.
Big Long Creek Drainage District	Gaston	1,200	Completed.
Crowder's Creek Drainage District	Gaston	1,200	Completed.
Dutchman's Creek Drainage District	Gaston-Lincoln	1,000	One-half completed.
Horsepen Creek Drainage District	Guilford	3,000	Petitioned for.
Reedy Fork and Haw River Drainage District.	Guilford-Rockingham	176,000	Progress unknown.
Falls-Byers Creek Drainage District	Iredell	600	Petitioned for.
Fourth Creek Drainage District	Iredell	1,700	Completed.
Fifth Creek Drainage District	Iredell		Preliminary examination made.
Third Creek Drainage District	Iredell	48,000	Completed.
Upper Third Creek Drainage District	Iredell	2,300	Final report made.
Winthrow's Creek Drainage District	Iredell		Preliminary survey begun.
Clark's Creek Drainage District	Lincoln-Catawba	2,400	Completed.
Indian Creek Drainage District	Lincoln		
Potts Creek Drainage District	Lincoln-Catawba	1,500	Petitioned for.
Drainage District, No. 2, of Big Sugar Creek	Mecklenburg		
Mecklenburg Drainage District	Mecklenburg	20,000	Work nearly complete.
McLendon's Creek Drainage District	Moore	1,500	Petitioned for.
Third Creek Drainage District	Rowan	3,949	Work not begun.

As is seen from the above table, there are forty-six districts in the swamp areas and thirty-four districts in the overflowed areas that will reclaim an aggregate of 942,121 acres. Of these districts, twenty-four are already completed, representing an acreage of 267,047 already reclaimed.

The reclamation of these lands means that land that was formerly bringing in no revenue to its owner is now producing ten to one hundred bushels of corn to an acre, one to two bales of cotton to an acre, and

other crops in like proportion, for it must be remembered that this reclaimed land is the richest in the State.

The State and county were formerly deriving but little revenue through the tax on this land, as it was listed at from 50 cents to $1 an acre. After it is drained and cleared it is worth $50 to $150 per acre.

A great deal of land, even after the surface water has been removed, needs a certain amount of drainage to remove the excess of water within the soil before it can be brought to the highest state of cultivation.

Some lands are capable of removing this excess of water by natural percolation, while others will remain wet or soggy until artificial means are provided to remove it. This can be done by tile drainage, and such drainage or farm improvement is being utilized more and more in this State as our people realize the enormous increase in the production of crops on the soil that has thus been improved. This phase of drainage should be particularly emphasized because of the very great loss upon many farms due to a certain proportion of the acreage being poorly drained. For instance, a twenty-acre field under cultivation may have four acres which are wet and soggy. They are, however, cultivated with the balance and receive the same amount of labor and seed, but in return they give but a very small percentage per acre of the production of the other acres. From the farmer's standpoint any increase in production on these four acres will be clear gain. By draining it, part surface and part tile, it can be made equally as productive as the balance of the field and probably more so, because it is apt to be richer soil.

"While a large volume of water is required to mature a crop, the amount should be so controlled that it will be supplied regularly as needed and without rendering soil conditions unfavorable to thrifty growth in other respects. It is stated by experimenters that three hundred to five hundred pounds of water are used in producing one pound of dry vegetable matter; that thirty pounds of water pass off through a single corn plant during its period of growth, and that on summer days one and four-tenths pounds of water are evaporated from a square foot of leaf surface. This enormous demand of plants is supplied only by rainfall, which is taken out of the soil through the roots, and seems an almost incredible amount when we remember that an inch in depth of water on one acre weighs one hundred and one tons, and that the annual precipitation of twenty inches to forty-eight inches is exceedingly irregular in time and variable in quantity. It is the office of drainage to remove the excess due to unusual precipitation from both surface and interior of the soil, place the latter in condition to conserve moisture during periods of drought, and make it possible for air to enter and perform the work so essential to the preparation of ele-

ments for the assimilation of plants. When this is done the many salutary effects so often observed and commented upon follow in natural order."*

The question is still sometimes raised, Does drainage pay? The results accomplished in North Carolina with both phases of drainage answer emphatically and indisputably that *thorough drainage* does pay, and it is one of the most profitable investments in North Carolina.

SPECIAL DRAINAGE WORK.

On March 11, 1914, the State Geologist, acting as arbitrator, made a special investigation of the Big Cold Water Creek Drainage District in Cabarrus County, in order to settle a dispute in regard to certain changes in the location of the main canal. The difficulty was satisfactorily adjusted and the canals have been completed, and there now seems to be general satisfaction in the district with the work accomplished.

During January, 1914, Mr. Lawrence Brett, drainage engineer, representing the North Carolina Geological and Economic Survey, made an examination of an extensive drainage area in Columbus County. As a result of this examination, a drainage district has been organized in the vicinity of Bolton.

November 6, 1914, the State Geologist visited the Bolton Drainage District of Columbus County and made an address at Bolton on the Reclamation of the Swamp Lands of North Carolina.

There has been prepared during the past two years a set of drainage forms covering the organization of drainage districts under the North Carolina Drainage Law, and also forms for minutes of boards of drainage commissioners. These forms, which were prepared by Mr. George R. Boyd, drainage engineer of the Survey, have filled a long-felt need and are of very material assistance in the organization of these districts.

Applications for these forms are also being received from other States, and it is very probable that similar forms will be prepared for those States which have in several instances adopted a drainage law modeled after the North Carolina Drainage Law.

COÖPERATION OF UNITED STATES OFFICE OF DRAINAGE INVESTIGATIONS.

The success of the drainage work in this State has been largely due to the most hearty and cordial coöperation that the State Survey has received from the Office of Drainage Investigations of the United States Department of Agriculture, which has been extended to the State Survey ever since it took up the question of the reclamation of the swamp and overflowed lands of the State.

*C. G. Elliott. North Carolina Geological and Economic Survey, Economic Paper 26, p. 16.

In July, 1912, a very satisfactory coöperative agreement was entered into between the Office of Experiment Stations, Drainage Investigations, United States Department of Agriculture, and the North Carolina Department of Agriculture, for the promotion of agricultural development in this State along drainage lines. Although the coöperative work looked particularly to farm drainage, yet very material assistance has been obtained in connection with the reclamation of swamp and overflowed lands for farm and health purposes.

The office of the United States Department was first established at Fayetteville, but in order to bring the work in closer touch with the State Department the office was moved from Fayetteville to West Raleigh in October, 1912, and to the State Agricultural Building, Raleigh, in September, 1914. The agreement between the two departments provided that an assistant be furnished to the field representative of the United States Department of Agriculture.

Mr. C. W. Mengel was in charge of the work up to November, 1912, when he resigned. Mr. D. L. Yarnell was then temporarily in charge until January 1, 1913, when Mr. H. M. Lynde was appointed chief engineer in charge of the work in North Carolina, and he has continued in this position up to the present time. He remained, however, in the office as assistant until March 27, 1913.

Mr. D. T. Harris was appointed by the State Department of Agriculture to represent the State in this coöperative work, and he served from March 10 to April 28, 1913, when he was obliged to resign on account of ill health. Since June 1, 1913, Mr. F. R. Baker has been assistant drainage engineer for the State.

Considerable general interest has been shown in tile drainage throughout the State, and preliminary surveys on twenty-eight farms scattered over seventeen counties and comprising a total area of about 1,200 acres have been made. The areas of the tracts varied in size from 5 to 200 acres.

Several requests have been made for assistance in the design of terraces to prevent hillside erosion. Several demonstrations of tile drainage construction methods have been made to gatherings of farmers throughout the State. Gauging stations for the determination of run-off have been maintained on Toisnot Swamp Canal, Wilson, Wilson County, and on Third Creek, Iredell County.

Mr. Lynde read papers before the sixth annual convention of the North Carolina Drainage Association on *The Work of the Drainage Engineer,* and the seventh annual convention, on *The Importance and Principles of Farm Drainage.* On March 28, 1914, he addressed a meet-

ing of landowners along Town Fork Creek, Stokes County, at Walnut Cove, N. C., explaining the operation of the North Carolina Drainage Law and the method of forming drainage districts.

In connection with work in the swamp and overflowed areas of the State, during the past two years twenty-three examinations and surveys of a preliminary or reconnoissant nature have been made, covering a total area of approximately 424,700 acres scattered over twenty-three different counties. In addition to these preliminary examinations, a survey and plan of drainage, with estimate of cost, was made of a portion of Jackson Swamp, Beaufort County, comprising an area of 5,000 acres. In the following table there is given a list of the areas examined:

Preliminary Examinations.

SWAMP LANDS.

District.	County.	Date Examined.	Engineer.
Eure	Gates	Mar. 13, 14, 1913	H. M. Lynde.
Holly Shelter Pocosin	Pender	Mar. 6, 7, 1913	S. H. McCrory.
Jackson Swamp	Beaufort	Mar. 18, 19, 1913	H. M. Lynde.
Little Contentnea Creek	Pitt	Aug. 8, 9, 1913	H. M. Lynde.
Godwin	Cumberland	Aug. 18, 1913	H. M. Lynde and F. R. Baker.
Bryan and Horsepen Swamps	Bladen	Dec. 16, 17, 1913	H. M. Lynde.
Clarkton	Bladen	Jan. 8, 1914	H. M. Lynde.
North Carolina Co. Tract	Columbus and Brunswick.	Jan. 9, 10, 11, 1914	H. M. Lynde.
Middle Swamp Bay	Brunswick	May 21, 1914	H. M. Lynde.
South Mills Drainage District	Camden	June 25, 1914	F. R. Baker.
Pamlico Drainage District, No. 1.	Pamlico	April 30, May 1, 1914	H. M. Lynde.
Carolina Farm Development Co.	Onslow	Dec. 15, 16, 1914	H. M. Lynde.

OVERFLOWED AREAS.

Roanoke River	Halifax	Dec. 31, 1912, and Jan. 1, 1913.	D. L. Yarnell.
Silver Creek	Burke	Feb. 1, 1913	D. L. Yarnell and H. M. Lynde.
Little Rocky Creek	Iredell	June 17, 1913	H. M. Lynde and F. R. Baker.
Irish Buffalo Creek	Cabarrus	June 18, 19, 1913	H. M. Lynde and F. R. Baker.
Third Creek	Rowan	June 27, 28, 1913	H. M. Lynde.
Grant's Creek	Rowan	Sept. 18, 19, 1913	H. M. Lynde.
Main and Little Knob Creeks	Cleveland	Dec. 19, 1913	H. M. Lynde.
McAlpine Creek	Mecklenburg	Dec. 18, 20, 1913	H. M. Lynde.
Coddle Creek	Cabarrus	Feb. 18, 19, 1914	H. M. Lynde.
Muddy Creek and tributaries	Forsyth and Davidson.	June 11, 12, 13, 1914	H. M. Lynde.
New Hope Creek and tributaries and Elebee Creek.	Durham	Sept. 21, 22, 1914	H. M. Lynde and F. R. Baker.

SURVEYS.

Jackson Swamp	Beaufort	Oct., 1913	H. M. Lynde and F. R. Baker.

NATIONAL DRAINAGE WORK.

CONFERENCE WITH SECRETARY OF THE INTERIOR.

On June 28, 1913, the State Geologist was invited by the Secretary of the Interior to meet in his office with several other engineers from different parts of the country to discuss the general drainage problem of the United States and to work out, if possible, what would be considered satisfactory drainage legislation. At this meeting the State Geologist was appointed a member of a subcommittee to work out the legislation problem. On July 9th there was a meeting of the subcommittee, with the Secretary of the Interior, together with the members of the National Drainage Congress, which resulted in the adoption of the legislation recommended by the subcommittee, both by the committee appointed by the Secretary of the Interior on July 10th and by the executive committee of the National Drainage Congress.

The executive committee was then requested by the Secretary of the Interior to draft the proposed legislation into a bill to be submitted to Congress.

On September 10th there was another meeting of the executive committee of the National Drainage Congress, which was attended by the State Geologist, at which meeting the legislation suggested was drafted into a bill which was subsequently introduced into the House of Representatives by Speaker Clark.

NATIONAL DRAINAGE CONGRESS.

The State Survey has been in close touch with the National Drainage Congress and the State Geologist has been a member of the executive committee and one of the four members of the board of governors of this congress for the past three years, and has taken an active part in preparing for the National Drainage Congresses held in St. Louis in 1913 and in Savannah in 1914. At both congresses the State had rather elaborate exhibits, illustrating the drainage work of North Carolina. These exhibits attracted a great deal of attention and resulted in considerable and valuable advertising of the reclaimed swamp areas of eastern North Carolina. In both of these congresses the State Geologist made addresses on the *Reclamation of the Swamp and Overflowed Lands of North Carolina.*

NORTH CAROLINA DRAINAGE ASSOCIATION.

One of the important factors in the reclamation of North Carolina's swamp and overflowed lands is the North Carolina Drainage Association, which has been closely identified with this reclamation work ever since it

was inaugurated by the passage of the North Carolina Drainage Act of 1909. This association and the State Survey have worked together to bring before the people of the State all information possible regarding the value and need of the reclamation of these swamp and overflowed lands, which has resulted in the progress report already given.

The State Geologist has assisted very materially in planning and arranging for the annual meetings of the State Association.

The 1913 convention was held at Charlotte, North Carolina, November 18th and 19th. At this convention there were representatives from the following counties: Anson, Cabarrus, Catawba, Cleveland, Gaston, Guilford, Iredell, Lincoln, Mecklenburg, New Hanover, Orange, Robeson, Stokes, Wake, and Wilson.

They passed the following resolutions, which represent the opinion and views of those attending the convention:

Whereas the problem of the drainage of our swamp and overflowed lands is one directly affecting the welfare of the Commonwealth, being of vital interest in conserving the health of the community at large, being necessary to the building of good roads and proper agricultural development, we invite the coöperation of the people of North Carolina in this great movement.

Resolved, That we urge the General Assembly to give careful attention to the necessity for legislation which will protect our drained swamp lands from fires and our drainage canals from damage caused by stock running at large. We commend to the consideration of our representatives at Raleigh the fact that our drained swamp and overflowed areas are of great value, and that their protection is a matter of public welfare.

Resolved, That this association regrets that many important amendments to the State Drainage Law failed to pass at the regular session of the General Assembly, and refers back to the legislative committee these matters for report at the next meeting.

Resolved, That we urge the General Assembly to establish, under the jurisdiction of the State Geological and Economic Survey, the office of State Drainage Engineer, and to appropriate a sum sufficient to provide for the employment of competent men and necessary assistants.

The proceedings of this convention of the North Carolina Drainage Association were published by the Survey as Press Bulletin 136.

The seventh annual convention of the North Carolina Drainage Association was held at Wilson, North Carolina, November 18 and 19, 1914. Representatives were in attendance from the following counties: Beaufort, Edgecombe, Gaston, Greene, Guilford, Hyde, Lenoir, Nash, New Hanover, Orange, Pender, Robeson, Wake, Washington, Wayne, and Wilson.

The resolutions adopted by this convention were as follows:

Resolved, That we urge the General Assembly to carefully consider what we have already done for the advancement of this work by investigating the good that has been accomplished in the way of agricultural development and incidentally increased revenues and values of farm lands, after which we feel that they can better see the needs for the coöperation of the whole State in this work.

Resolved, That we urge the General Assembly to give careful attention to the necessity for legislation which will protect our drained swamp lands from fires and our canals from damage caused by stock running at large. We commend to the consideration of our representatives at Raleigh the fact that our drained swamp land and overflowed areas are of great value and that their protection is a matter of public welfare.

Resolved, That this association coöperate in any State- or Nation-wide movement to encourage immigration to this State. We realize that one of the most important factors in the success of the drainage work is the bringing in of a desirable class of settlers who will live on their lands and cultivate them. We should welcome and aid the newcomer, and he will make us a good citizen and aid us in realizing the possibility of ours.

Resolved, That we commend to the General Assembly the State Geological and Economic Survey as worthy of most generous support, representing as it does most important activities that are constructive forces in the upbuilding of our State.

Resolved, That we extend our thanks to the United States Department of Agriculture, to the Office of Experiment Stations, and to the Board of Drainage Investigations for the aid they have given in solving our drainage problems, and in placing in our State an able and efficient drainage engineer to advise our people and help us with our work.

Resolved, That we extend the thanks of this association to the State Department of Agriculture and to its various officials for the work done by demonstration farms and soil surveys and in placing an engineer in the field to aid in drainage work.

SUGGESTED DRAINAGE LEGISLATION.

As stated in the resolutions adopted by these two drainage conventions, it is the opinion of those who have made a close and thorough study of the drainage problem of the State that the legislation suggested to the General Assembly of 1913 should have been passed in the interest of the development of this State. After two years further consideration of the drainage problem, the State Geologist is still of the opinion that his previous recommendations are in the line of progress and are necessary to the State's obtaining the greatest and fullest benefit from the reclamation of its swamp and overflowed lands.

I am, therefore, suggesting to the General Assembly of 1915 the following legislation relating to drainage, and not only ask their favorable consideration of this, but recommend that it be enacted into law:

SUGGESTED DRAINAGE LEGISLATION.

The General Assembly of North Carolina do enact:

SECTION 1. That it shall be the duty of the drainage commissioners of any drainage or levee district, organized and incorporated by and under authority of chapter 442 of the Public Laws of 1909, to have prepared at once a map of the drainage district which shall have platted thereon the boundaries of the district, together with the boundaries of the various tracts of land within the boundaries of the district, with the name of the owner properly marked on map, so that it will be possible to identify the ownership of any such tract of land; and that a certified copy of said map shall be deposited with the clerk of the court and the sheriff of the county or counties in which the drainage district is located.

SEC. 2. Any and every person owning land in any drainage district, organized and incorporated by and under authority of chapter 442 of the Public Laws of 1909, at the time of its incorporation or any time thereafter while the district remains under the control of the incorporated board of drainage commissioners, upon selling all or any part of his holdings in said district, shall have prepared and forwarded to the clerk of the court and the sheriff a certified copy of a plat showing accurately what part of said parcel or tract of land has been sold, together with the name of the purchaser of said tract. Any one failing to comply with this section shall be liable for the special drainage tax on said land; and this tax shall be collected by the sheriff from the owner whose name is last indicated on the certified copy of the map of the district in the clerk of the court's office.

The clerk of the court and the sheriff shall, on receipt of the certified copy of the plat of the tract of land sold, have this platted and incorporated as part of the map previously furnished him by the board of drainage commissioners.

SEC. 3. That section 14 of chapter 67 of the Public Laws of 1911 be amended by adding thereto the following: "*Provided further*, that if the drainage district is established and the board of drainage commissioners of said drainage district shall not refund to the State Treasury to the credit of the Department of Agriculture said sum or sums that have been loaned to the district as the first payment out of the funds received from the sale of the bonds of the district, each and all three of the commissioners of the board of drainage commissioners shall be guilty of a misdemeanor and subject to a fine and imprisonment; and the State Treasurer is herewith authorized and instructed to bring suit against said district for the amount of the loan and interest thereon: *Provided further*, that if the drainage district is not established and the said sum or sums loaned to the district are not refunded to the State Treasury to the credit of the Department of Agriculture by the petitioners for the drainage district within sixty days after the court has decided against the organization of the district, the State Treasurer is hereby authorized and instructed to bring suit against said petitioners for said loans, and against the sureties on their bonds."

SEC. 4. That the State Treasurer is herewith authorized to receive North Carolina drainage bonds as deposits from banks, insurance companies, and other corporations required by law to make deposits with the State Treasurer: *Provided*, that the Attorney-General shall have approved the form of bond before said bond is issued by the commissioners of any drainage district.

SEC. 5. That it shall be lawful for executors, administrators, guardians, fiduciaries generally to invest in said bonds.

SEC. 6. That the members of the board of drainage commissioners of any drainage district, organized by and under authority of chapter 442 of the Public Laws of 1909, shall be allowed four dollars per diem and traveling expenses incurred in carrying out their duties as said commissioners, which shall be a legitimate charge against the district, and shall be paid by the treasurer of the district out of any funds to the credit of said district: *Provided*, the commissioners shall be paid not to exceed fifteen days in any one year during the expenditure of the bond issue in the construction of the canals and ditches of the district. After that time they shall be paid not to exceed three days in any one year.

SEC. 7. That section 20 of chapter 442 of the Public Laws of 1909 is herewith amended by adding thereto the following: "That the superintendent of construction shall be allowed such salary and expenses as shall be determined by the board of drainage commissioners."

SEC. 8. That, in order to assist the people of the State in the organization of drainage districts in the swamp and overflowed areas of the State, and to make preliminary surveys regarding the feasibility and practicability of the drainage of said areas, there is appropriated annually out of any moneys in the State Treasury not otherwise appropriated the sum of three thousand dollars for the purpose of carrying out the provisions of this act, the same to be drawn upon as directed by the Geological Board, upon warrant of the State Auditor.

MAGNETIC SURVEY.

During the years 1898 and 1900, inclusive, there was established at the county-seats of the several counties of the State meridian monuments for determining the variations of the magnetic needle of the compass from the true North and a standard length for measuring surveyors' chains. These stations are marked with solid granite posts, weighing about four hundred pounds each, with the top of the monument dressed about six inches square and lettered N. C. G. S. and U. S. C. & G. S. These stations were established by the United States Coast and Geodetic Survey in coöperation with the North Carolina Geological Survey, and since their establishment the State has had the hearty coöperation of the Federal bureau in having magnetic observations made at the old stations and establishing new stations when for one cause or another it became necessary to remove the monuments. This has been necessary in several cases on account of the erection of a new courthouse at a county-seat. They have also during subsequent years established stations at the county-seats of new counties.

During the past two years the United States Coast and Geodetic Survey has, on application of the State Geologist, carried on the following work. Only one "repeat" station was occupied during the year 1900. This was the Raleigh station, which was occupied in June, 1913. This observation showed the declination of 2° 48′ West. The previous observation was in August, 1906, when the declination was 2° 21.8′ West. This makes the average annual change –3.8.

MAGNETIC OBSERVATIONS MADE DURING 1913 AND 1914.

Magnetic observations made by the United States Coast and Geodetic Survey at the several stations in North Carolina during the period December 1, 1912, to November 30, 1914, are given in the following table:

Results of Magnetic Observations Made in North Carolina by the United States Coast and Geodetic Survey Between December 1, 1912, and November 30, 1914.

Station.	County.	Latitude.	Longitude.	Date.	Declination (West).	Dip.	Horizontal Intensity.	Instruments.		Observer.
								M.	D. C.	
Raleigh	Wake	35 47.3	78 40.6	June 17, 18	2 48.0	67 54.7	21755	17	76.12	J. R. Benton.
Wake Forest	Wake	35 56.4	78 31.1	June 19, 20	3 22.4	67 54.5	21674	17	76.12	J. R. Benton.
Franklinton	Franklin	36 06.9	78 27.2	June 21	2 59.5	68 18.8	21359	17	76.12	J. R. Benton.
Whitakers	Edgecombe	36 06.9	77 44.2	June 25, 26	2 57.8	68 13.5	21407	17	76.12	J. R. Benton.
Scotland Neck	Halifax	36 07.7	77 24.7	July 1, 2	4 18.4	68 04.8	21480	17	76.12	J. R. Benton.
Enfield	Halifax	36 11.6	77 39.7	June 27	3 49.5	68 21.6	21228	17	76.12	J. R. Benton.
Littleton	Halifax	36 25.4	77 55.6	June 24	4 18.3	68 24.1	21237	17	76.12	J. R. Benton.

If these observations are made at new stations, the magnetic observers are instructed to mark every station in as permanent a manner as possible, either with a stone or a post of some durable wood, so that it may be available for future occupation. Wherever possible there is used a stone post about three feet long and six inches square, set so as to project two or three inches above the ground. In the center of the top is set a circular brass plate three and one-half inches in diameter, lettered "Magnetic Station United States Coast and Geodetic Survey, Washington, D. C. For information, write to superintendent. Two hundred and fifty dollars fine or imprisonment for disturbing this mark."

If the local authorities at these new observation stations desire it, and are willing to bear the expense, a second stone is erected to mark the true meridian.

They are also required to furnish a sufficiently detailed description to locate the station even if the mark should be destroyed. While only abridged description of these stations is given in the following pages, additional details can be obtained upon application to the superintendent of the Coast and Geodetic Survey, Washington, D. C., so that any one will be able to locate the station. The observer has determined the bearings of two or three prominent objects in addition to the one used as reference mark in the azimuth and declination observations.

There is given below descriptions of the stations from which the observations were made in 1913 and 1914:

STATIONS IN NORTH CAROLINA.

Enfield, Halifax County.—Observations were made at a point about three-fourths mile north of town, on property belonging to Mr. L. B. Mann, located just south of the cemetery for colored people and just west of the Atlantic Coast Line tracks. The point is 58 feet east, approximately, from the east side of a road which passes west of the cemetery, and is 85 feet south, approximately, from the south fence of the cemetery. It is marked by a 2-foot length of 6-inch drain tile, projecting about 3 inches above the ground, and having a brass magnetic station marker cemented in the top. The following true bearings were determined:

West side of top of smokestack one-half mile away (mark)	25°	19.4′	west of south
Northeast gable of house about 600 feet away	1	00.5	east of north
Center of windmill, 700 feet away	31	35.5	east of north

Franklinton, Franklin County.—Observations were made at a point about one-half mile north of the center of town, on property belonging to Mr. Ed Morris, near the northwest corner of the grounds of the graded school. The point is 158 feet north of the northwest corner of the school building, 27 feet east-northeast of a young cherry tree, 9 feet high with two forks, and about 280 feet west of the west edge of the highway. It is marked by a piece of terra-cotta flue pipe 2¼ feet long and 6 inches in diameter, set with its bell end 6 inches above the ground, and having the upper end filled with cement, in which the brass magnetic station marker is set. The following true bearings were determined:

Steeple of Baptist Church (mark)	29°	39.7′	west of south
East gable of white house about 800 feet away	52	07.7	west of south
Southwest gable of house visible over hilltop about 1,000 feet away	58	53.4	east of south

Littleton, Halifax County.—Observations were made at a point about one mile south of the center of town. The point is located in a pasture belonging to Mr. John Leach, reached by the main highway to Panacea Springs. It is about 800 feet northeast of the Leach mansion, 57 feet west of the east fence of the pasture, 97 feet north of a tree about 3 feet in diameter which leans to the south about 20 degrees from vertical, and 140 feet east-southeast of an oak tree 3½ feet in diameter. The station is marked by a 2-foot length of 4-inch drain tile, set with its bell end about 3 inches above the ground. The following true bearings were determined:

North gable of house or shed about one-fourth mile away (mark)	69°	50.0′	east of south
East gable of barn about 500 feet away	7	16.0	east of south
Northeast corner post of fence around Leach mansion	56	03.1	west of south
East gable of barn about 1,000 feet away	78	16.5	west of north

Raleigh, Wake County.—The station of 1906 was reoccupied. It is on the fair grounds about one-fourth mile from the nearest trolley line and about 2 miles from the center of Raleigh, past the Agricultural and Mechanical College property and fair grounds. The station is 78.1 feet from the nearest corner of the house occupied by Mr. Ross, 46.5 feet east of the west fence on the fair grounds property, 84 feet south of a fence running east and west, and about 250 feet north of the highway. It is

marked by a marble post 6 inches square, projecting about 2 inches above the ground and lettered C. & G. S. The following true bearings were determined:

Northeast edge of cross on Catholic Church	1°	17.7′	west of south
Northwest edge of chimney on end of Catholic Orphanage	13	12.8	east of south
Spire on glass turret of hospital	32	39.8	east of south
Top of water tank next to Experiment Station building	40	04.1	east of south
Top of floral building on fair grounds, center of base of flag-pole	68	07.9	east of south

Scotland Neck, Halifax County.—Observations were made at a point about one-fourth mile northeast of the railroad station, in the southeastern part of the race-track grounds and northeastern part of the baseball grounds, situated inside of the running track. The point is about 49 feet west of the inside edge of the track, and about 31 feet south of the south edge of a road running across the space inside the track, and separating the baseball grounds from the rest. The grounds belong to the Kitchin estate. The point is marked with a 2-foot length of 6-inch drain tile, set with its bell end even with the ground; the bell end is filled with Portland cement, in which there is a magnetic station mark. The following true bearings were determined:

Water tank about 2,000 feet away (mark)	29°	36.0′	west of north
Water tank about 1,000 feet away	34	04.9	west of south
Steeple of church	72	43.6	west of south
Steeple of church	88	16.2	west of north
Steeple of Episcopal Church	80	14.6	west of north

Wake Forest, Wake County.—Observations were made at a point in the grounds of a country schoolhouse about two miles south of Wake Forest and about one mile south of Forestville, reached by the main highway to Raleigh, and on the east side of the highway. The point is about 170 feet from the east edge of the highway, about 65 feet from the (unmarked) northeast boundary of the school property, 96.5 feet east of the east corner of the school building, 175 feet southeast of the northernmost of a set of guy poles of the telephone line, and is in line with a north and south stretch of the highway just before reaching the school. The station is marked with a 2-foot length of terra-cotta flue pipe set with its bell end even with the ground, the upper end filled with Portland cement and having a brass magnetic station marker in the top. The following true bearings were determined:

South upper gable of barn about 800 feet away (mark)	23°	17.8′	west of north
Southwest edge of stone chimney about 1,000 feet away	35	24.8	west of north
East gable of house about 800 feet away	51	45.1	west of south
Rope in well about 1,200 feet away	31	33.0	west of south

WHITAKERS, EDGECOMBE COUNTY.—Observations were made at a point about one-fourth mile southwest of town in the northwest part of the grounds of the graded school. The point is 120 feet northwest of the northwest corner of the school building, 50 feet east of the west boundary of the grounds, and 49 feet south of the north boundary. It is marked by a 2-foot length of 4-inch drain tile, set with its bell end even with the ground and having a brass magnetic station marker cemented in the top. The following true bearings were determined:

Center of ball on church steeple	82°	31.2′	east of north
South gable of small unpainted house against woods one-fourth mile away	78	07.5	west of north
West edge of top of chimney of two-room house about 1,000 feet away	10	52.7	east of north

ADDITIONAL WORK IN NORTH CAROLINA OF THE UNITED STATES COAST AND GEODETIC SURVEY.

In addition to the magnetic observations, the United States Coast and Geodetic Survey has assisted the State Survey in connection with marking by buoys the restricted areas in the fishing territory under the supervision of the North Carolina Fish Commission.

There has also been a certain amount of topographic and hydrographic work carried on in North Carolina, as follows:

TOPOGRAPHIC WORK.

Revision of shore line of Alligator River. Same for Pamlico River in the vicinity of Washington, N. C. Revision of coast line and entrance to Beaufort, and mouth of Core Creek. Revision of coast line around Cape Fear. Revision of topography at head of Bay River.

HYDROGRAPHIC WORK.

Numerous shoal spots examined in Pamlico River up to Washington, N. C. Shoal spots examined in entrance to Neuse River. Hydrographic examination of channel at head of Core Sound. Hydrographic resurvey of inside waters from northward of Cape Lookout to Morehead City, N. C. Hydrographic survey around Cape Fear, and also in the entrance to Cape Fear River.

The triangulation work accomplished by the United States Coast and Geodetic Survey during the past two years has been as follows:

Bogue Sound to Wrightsville.

Beaufort Harbor and vicinity.

The Straits and Bock Sound.

Neuse and Bay rivers.

Alligator River, North River, and part of Albemarle Sound between them.

Pamlico River, Washington to mouth, and shore of Pamlico Sound to Swan Quarter.

FISHING INDUSTRIES.

ECONOMIC VALUE OF FISHERIES.

The people of North Carolina do not yet realize the economic value of the fisheries of the State, nor do they realize the importance of fish and oysters as a food supply, and our legislators have been too apt to consider the fishery problems as local or county questions. Instead of its being a local question, the fishing problem is a State-wide matter, because, in the first place, navigable waters in the State are absolutely under the control of the Federal and State governments, and the fish that live in these waters belong to the State as a whole and not to the county or community in which the waters happen to be located; in the second place, every person in the State has a perfect and constitutional right to fish in any of the navigable waters belonging to the State, and because of such rights he is, or should be, interested from a personal standpoint in the protection and conservation of the fish inhabiting the waters; and, in the third place, the protection of the fish and the fostering of the fishing interests cannot be carried on by a county, but must be undertaken by the State if the measures advocated are to be carried out successfully. Thus, in passing laws to protect and foster our fishing industries we must consider the State before the county and the whole people before the individual.

OWNERSHIP OF FISHERIES.

It seems to me that in considering fisheries legislation a fundamental resolution as given below should be passed by the Legislature, which should relate to its ownership of the fisheries, and the passage of such a resolution would undoubtedly very materially aid in the passage of the proper legislation for the protection and perpetuation of the fisheries of the State:

"That the State of North Carolina herewith recognizes the fact that all natural fishery products are exclusively the property of the State; that the State has the right and power to exercise such control over the fishing for these sea products as shall insure their perpetuation; that the State can prohibit the taking of one or of any of these products; and that in authorizing and permitting the citizens of the State to fish for any of these products the State must receive a satisfactory fee or tax for this privilege, and shall pass and enforce such rules and regulations governing the fisheries so that they shall not be destroyed by reason of the legalized fishing."

With the passage of such a resolution by the Legislature, it should be possible to obtain the passage of any act that may be necessary to conserve the industry.

CONTROL OF FISHERIES.

Now, it seems to me that the best results can only be obtained when there is a centralized or general control of the fisheries as opposed to a local one. There must be some central body that has jurisdiction over all the fisheries and has the power to make and enforce rules and regulations governing these fisheries; and that such rules and regulations shall not be made or even enforced by any local body. This centralized authority is particularly important in connection with the oyster and clam, but is necessary in connection with all fisheries.

If the State will recognize its ownership of these fisheries, then it should realize that the only way to protect and conserve them is to centralize their control in a commission clothed with power to act, and not leave it to any local control. I believe in the State there should be but one commission, "The Fisheries Commission," and that this commission should have jurisdiction over all the commercial fisheries of the State, and that it should be clothed with the following authority:

To regulate, prohibit, or restrict, in time, place, character, and dimensions, the use of nets, appliances, apparatus, or means employed in taking or killing fish; to regulate the seasons at which the various species of fish may be taken in the several waters of the State, and to prescribe the minimum sizes of fish which may be taken in the said several waters of the State; and such regulations, prohibitions, restrictions, and prescriptions, after due publication, shall be of equal force and effect with the provisions of an act of the Legislature; and any person violating the regulations prescribed by the commission shall be guilty of a misdemeanor, and upon conviction shall be fined or imprisoned at the discretion of the court: *Provided, however,* that if a petition signed by five or more voters of the district or community which will be affected by any proposed change is filed with the Fisheries Commission through the

Fisheries Commissioner, assistant commissioners or inspectors, asking that they have a hearing before any proposed change in the territory, size of mesh, length of net, or time of fishing shall go into effect, petitioning that they be heard regarding said change, the Fisheries Commission shall in that event designate by advertisement for a period of thirty days at the courthouse and three other public places in the county affected, and also by publication in a newspaper of the county, if such is published in said county, for two consecutive weeks, a place at which said board will meet and hear argument for and against said change, and may ratify, rescind, or alter this previous order of change as may seem just in the premises.

This may seem like conferring extraordinary power on the commission; but is it any more so than that conferred on State boards of agriculture, corporation commissions, and tax commissions? I think not, and in this particular case the State is conferring authority on a commission that is to look after something that belongs absolutely to the State. No general law regulating fishing can be passed that will be applicable to all localities, and it is absolutely necessary for some commission or body to be in a position to pass and enforce regulations as will meet local requirements and conditions. Now, what commission, board, or body can be more efficient to handle these questions than the commission I have referred to? Such a commission would have appointed by them a commissioner and deputy commissioners, who would be in direct charge of the active work.

The above suggestion is similar to the law in force in the Dominion of Canada that has proved so efficient.

As far as possible, the appointments on the Fisheries Commission should be made on account of special qualifications of the appointee for the commissionership, and not made simply because the appointee has been of service to the dominant political party, and I believe that it will work out more practically if one or more members of the commission shall be of the minority party. All appointments made by the commission should be for merit and absolutely unaffected by political affiliation of the appointee.

There is no disputing the fact that politics has and is playing a decided part in the fisheries of the several States. This has been especially true of Maryland, New Jersey, Virginia, North Carolina, Rhode Island, and several other States.

The State's fishing industry demands a rational and businesslike treatment removed from politics, and it needs as its controlling factor a practical, unbiased, and State-wide interested commission that is beyond politics.

CONSERVATION AND PERPETUATION OF THE FISHERIES.

We may carry on the most elaborate investigations regarding the habits of the various fish in our waters, work out practical methods as how to protect them, to conserve them, to market them, and with our shellfish how to prevent pollution; but such investigations will be almost worthless to us in building up the industry unless we have the means by which results can be utilized, and they will not be utilized to the benefit of the fisheries of a State when the control of the fisheries is left entirely to a legislature or conferred upon local bodies. Only through such a commission as outlined can the results of these investigations be utilized to the best advantage.

It is possible to perpetuate our fish and oyster industries by enactment and enforcement of adequate laws; but the suggestions for the laws should not come from the individual or corporation that is interested in particular localities, but should come from a commission that is thoroughly familiar with conditions all over the State, and through its investigation is competent to make suggestions that will build up and never in any way destroy any part of the fishing interest. It seems to be the consensus of opinion of those who have made a thorough study of the fish industries that the only method for the practical enforcement of laws regulating fishing and of fostering the industry is through the operation of the fisheries commission. The work of such a commission would go beyond that of simply enforcing the laws, and should carry on investigations relating to the various fishing industries, the studying of local conditions which make it possible for the commission to render a just decision regarding what is the best thing to be done in relation to the perpetuation of the oyster and any type of fish. As I have already stated, up to the present time these conditions have been considered locally, while they should be considered as State questions, and the best results can only be obtained when they are thus considered.

During the past few years nearly all of the trouble that has come up in connection with legislation suggested to our various legislatures has been caused by the attempt of those interested in some special phase of the fishing industry or in some particular locality to have laws passed that will assist them in some way, regardless of the effect that the passage of such legislation will have upon other localities or upon the fishing industry as a whole.

A fisheries commission as outlined above will, I believe, in a few years be given such consideration in a State that the General Assembly of such State will not pass any fish legislation that is not approved by the commission. This is as it should be.

The United States Bureau of Fisheries is in a position to give competent, wise, and sane advice regarding not only scientific questions that come up regarding our fisheries, but also regarding the best way in which a State should handle these industries.

OPINION OF UNITED STATES BUREAU OF FISHERIES.

In regard to the question we are discussing this bureau states:

"The fish must be given access to their spawning grounds, and the hatchery must be granted every facility for obtaining its supply of eggs. The nets must be restricted as to location, and, if necessary, as to number and size, so as to furnish an avenue of passage for the fish. Furthermore, the laws must be so drawn that, while restricting reckless fishing, they must not interfere with the capture of fish for the specific purposes of artificial propagation, nor make the cost of obtaining ripe eggs so high as to be prohibitive.

"That these ends may be effectively attained it is obligatory that the administration of the laws be vested in State officers and not committed to county authority with local prejudices and a limited purview. Local regulation of the fisheries has everywhere proved a complete failure, and to experiment with it is to invite disaster to the fisheries committed to its care."

In referring to a law prepared for North Carolina along the lines mentioned above, and which was recommended by a committee of the General Assembly of North Carolina, the United States Bureau of Fisheries states:

DEPARTMENT OF COMMERCE AND LABOR,

BUREAU OF FISHERIES.

WASHINGTON, Nov. 28, 1910.

DR. JOSEPH HYDE PRATT, *State Geologist,*
Chapel Hill, N. C.

SIR:—The Bureau acknowledges the receipt of your letter of November 15th, submitting for criticism the report of the joint legislative committee on fishery matters which will be transmitted to the North Carolina Legislature of 1911. The Bureau has examined the proposed laws with care, and is pleased to observe that they have both the breadth and flexibility essential to meet the conditions obtaining in North Carolina. It centralizes the administration of the fisheries regulations, while at the same time placing at the service of the commissioner the advice, and, if need be, the control, of a body free from bias and local association with the fishing communities.

Safeguarded by this provision, the commissioner properly is given a wide discretion concerning the details of the regulations. While the broad principle of State control of the fisheries is in the opinion of the Bureau the only plan that will prove of lasting value, it is essential that recognition be made of the fact that identical regulations as to nets, close seasons, etc., are not applicable to all localities. After some experience and investigation, the commissioner will

be in an unequaled position to recommend such regulations as will meet the local requirements and conditions. In respect to this, the Bureau believes that the proposed law is superior to the systems applied in other States and equal to that which has demonstrated its efficiency in the Dominion of Canada. The Bureau is pleased also that there is proposed statutory recognition of the principle of an open channel for the access of fish to the upper waters.

The Bureau feels that it can properly indorse the conclusions of the committee, and express the hope that they may be enacted into law for the benefit of not only the fishing communities, but the State of North Carolina as a whole.

Respectfully,

H. M. Smith,

Acting Commissioner.

INEFFECTIVENESS OF LOCAL CONTROL OF FISHERIES.

I want to illustrate the ineffectiveness of fish protection without a central body. Take, for instance, the shad industry. It will be absolutely impossible for local legislation to have any material effect upon such a fish. During the winter season the shad lives somewhere off the coast; but in the spring at the approach of the spawning season they run into the inlets, up the sounds, seeking the fresh water in which to spawn. A local desire for immediate profit will make it quite possible for the people in the lower sections of the sounds and rivers to so place their nets that they can practically take all of the fish that come into these sounds and rivers, and thus prevent them from reaching the upper waters. On the other hand, if the men in the lower sounds and rivers fish according to law and do not block the waters with nets, it is possible for the fishermen in the upper section to so fish as to take practically all the fish, and thus prevent the shad from spawning. Now, the fishermen in the county controlling the lower waters have no right to prevent the fishermen of the upper county from obtaining their supplies of fish any more than the upper counties have a right to destroy the fishing to the detriment of the lower counties. If left to local control, it will mean left to the control of purely local interests. There will be no protection, and there will be constant conflict between the upper and lower counties.

Local control has nearly wiped out the sturgeon industry of North Carolina and other States; greatly decreased the mullet industry by reason of the catch of undersize mullets; is depleting the striped bass and black bass industries, and has nearly destroyed the oyster industry in many sections. On the other hand, central control of our fisheries has built up the shad industry in many sections; has completely restored the oyster industry in several States, as Louisiana, Virginia, Rhode Island, Connecticut, etc., and is capable of restoring the fisheries of any State unless they have been completely destroyed.

NO FOOD FISH TO BE USED FOR FERTILIZER PURPOSES.

There is one law that should be passed by every State and which should be rigidly enforced: that no food fish shall be used under any circumstances for fertilizer purposes. The nonenforcement of this law is helping to a considerable extent in the depletion of our food fish. Another regulation relating to size of fish that can be taken should also be rigidly enforced, and should be so worded that it shall be a misdemeanor for any one to have any undersized fish in his possession. Central control by the Fisheries Commission will enforce such law; local control, as a magistrate or county sheriff, cannot, or more often will not, enforce them. With migratory fish it may be necessary in many sections of the country to have Federal laws and Federal authority, as in some instances several States border on the sounds and rivers into which migratory fish pass to spawning grounds, and it is not always possible to get States to agree to a fishery policy that is just and equitable to all.

SPECIAL OYSTER LEGISLATION.

While it is important to protect and conserve the natural oyster rock and bed and to do everything practicable to make them last as long as possible, yet it will become absolutely necessary for a State to begin the cultivation of the oyster if it wishes to supply the demand. The oyster culture will be under private ownership, but the State should retain its ownership to the sea bottom and derive a revenue for leasing those that are suitable for oyster cultivation. I do not believe it is a wise proposition for any State to sell its ground for oyster cultivation.

With the cultivation of the oyster new rules and regulations must be enforced, and this can only be done satisfactorily through a Fisheries Commission. Cultivated beds must be protected; investigation must be taken up regarding any causes that exist which are destroying the beds, and the public must be protected from polluted oysters.

In connection with oysters taken from the natural rocks, culling laws must be enforced, and it should be a misdemeanor for any one to have unculled oysters in his possession; the open season for catching oysters must be limited, and method of dredging must be controlled.

COÖPERATION OF FEDERAL DEPARTMENTS.

UNITED STATES BUREAU OF FISHERIES.

The North Carolina Geological and Economic Survey and the North Carolina Fish Commission have for many years received the most cordial coöperation of the United States Bureau of Fisheries. In the report

of the Commissioner for the year ending June 30, 1914, he states as follows regarding the "Condition of the North Carolina Fisheries":*

CONDITION OF THE NORTH CAROLINA FISHERIES.

"In view of the active coöperation which for many years has existed between the Bureau of Fisheries and the North Carolina officials having charge of fishery matters, and because of the aid which has been given to the local fisheries by the work of artificial propagation on Albemarle Sound and tributaries, a brief review of the situation is appropriate at this time.

"The history of the fisheries of North Carolina is similar to that of most other communities in which the regulation of the industry has been in obedience to local demands, prejudices, and jealousies rather than based on broad principles having in view the interests of the State as a whole and a proper regard for the future welfare of both the fisherman and the consumer. There was at first a gradual increase in the yield, owing to the growth of markets and the improvement of means of transportation, the demand thus stimulated resulting in an increase in the number of persons and the quantity of apparatus employed. For a period this increase in the intensity of the fishery had no very conspicuous influence on the apparent abundance of the fishes, the effects being further obscured in the view of the fishermen by an increase in the unit price of the products, due to broader markets. Eventually, however, the decrease in the fishes began to manifest itself in the catch, and this was most conspicuous in the more desirable and higher-priced species like the shad. From 1880, the earliest year for which data are available, the catch of this species gradually increased under the operation of the factors just mentioned, but after attaining a maximum about 1897, it declined rapidly and in 1904 had sunk to the level of 1880. Essentially the same conditions obtained with respect to other species, although the catch of food fish as a whole was well maintained because many of the cheaper fish, justly or unjustly regarded as inferior, which in the earlier period were but little utilized, at a later date came into greater demand and found a market which the fishermen could supply with profit.

"About the time the decrease in the shad became critical and was imposing a serious decrease in the profits of the fishermen, an inquiry was instituted by the Bureau of Fisheries which demonstrated that the most important, if not practically the sole, cause of the decrease was the excessive use of fishing apparatus of all kinds, fished promiscuously in the

*Annual report of the Commissioner of Fisheries to the Secretary of Commerce for the Fiscal Year Ending June 30, 1914, pages 23-25.

inlets, channels, and sounds so as to effectually block the passage of the shad and other anadromous fishes to their spawning grounds.

"Moved by a consideration of these facts, the Legislature of North Carolina, in 1905, passed an act, popularly known as the Vann bill, which prohibited fishing in certain of the inlets leading from the sea to the sounds, and restricted the use of pound nets in the upper part of Pamlico Sound and all of Croatan, Roanoke, and Albemarle sounds, to certain prescribed zones. As amended in 1909, this law now preserves from all nets a strip of varying width extending from the ocean inlets to and up the rivers discharging into Albemarle Sound.

"There is thus created a broad avenue in which the shad and other anadromous fishes may travel without obstruction from the sea to their spawning places in the rivers. The effect of this has become increasingly apparent and perhaps may be illustrated best by the history of the operations of the Bureau's hatchery at Edenton, N. C., at the end of Albemarle Sound. The station was established in 1889 for the utilization of the eggs from shad resorting to the spawning beds in Chowan River and the adjacent parts of the sound. Its first year of effective operation was 1901, when 75,400,000 eggs were taken. In 1902 the take fell to 37,987,000, and by 1905 the number of eggs secured had fallen by stages to 6,748,000. In 1906, the year in which the Vann bill became effective, 25,643,000 eggs were taken; in 1909 the take was 59,685,000; in 1913 it had risen by rapid stages to 138,912,000, and even this number could have been exceeded if the capacity of the hatchery at that time had permitted the eggs to be handled. The season of 1914 showed a temporary decline owing to unfavorable weather conditions.

"The shad fishery in Albemarle Sound in 1913 was generally said to be the greatest for many years, if not in the history of the locality. The facts are a vindication of both rational legislation and shad culture. The hatchery was ineffective so long as the fish were prevented from reaching the spawning beds where ripe eggs may be obtained, but as soon as an unobstructed way was opened by the enforcement of a reasonable law, its operations could be conducted on a scale sufficient to warrant expectation of economic results. The effects of the heavier plants of recent years are in turn manifested both in the increase in the product of the fishery and in the number of eggs obtained.

"Fortified by the conspicuously good effects which followed the passage of the Vann law, the friends of fishery conservation in North Carolina have been endeavoring to have its essential features extended to all maritime parts of the State, and the movement to that end has been supported

and aided by the Bureau. In 1906 a canvass of the shad fisheries of the State was made by an agent of the Bureau, and practically every year since then an assistant has been detailed to assist and advise in the campaign which has been waged. Although the desired legislation has not been enacted, each year has shown a greater willingness of the fishery interests of most parts of the State to break away from the ineffective and pernicious system of county control and special local regulation, and to adopt the broad principles of State administration, without which no effective laws can be drafted or enforced."

FISHING BANK OFF BEAUFORT, N. C.

An interesting part of the report relates to certain investigations of the waters off the coast of North Carolina, the result of which has been the finding of a fishing bank off Beaufort, North Carolina, that is regarded as favorable to the development of a sea bass fishery.

In commenting upon this discovery, Dr. Smith writes as follows:*

"In 1902 the Bureau made a reconnoissance of a fishing bank off Beaufort, N. C., which demonstrated the abundance thereon of sea bass or blackfish. The information was not specially called to the attention of the fishermen and was not availed of, but during 1913 certain fishermen were induced to try this bank. As an indication of the value of these grounds it may be noted that two fishermen, between June 18 and November 22, made twenty-three trips twenty miles to sea in a 20-foot, open, power dory, and although they could remain but a few hours on the grounds, they averaged about 600 pounds of fish to the trip. Their minimum catch was 170 pounds, the maximum 1,000 pounds; and in the week ending November 22, in four trips, they took 3,400 pounds, for which they received an equivalent of $238, f. o. b. Beaufort, as the proceeds of a week's work. They have just built and launched a sea-going gasoline boat, with auxiliary sails, which will enable them to remain on the fishing grounds overnight and much increase the efficiency and profit of their operations.

"The outlook was regarded as favorable to the development of a remunerative sea-bass fishery, and the steamer *Fish Hawk* was detailed for further examinations. A number of other banks were found and reported on, and a circular was issued furnishing information as to their location and productiveness. At the end of the fiscal year arrangements were made to place a buoy on the principal bank to assist the fishermen in locating the most productive grounds."

*Ibid. Pages 62-63.

WORK OF THE BEAUFORT LABORATORY.

At Beaufort, N. C., is one of the laboratories belonging to the Bureau of Fisheries. While this laboratory is only maintained by the Federal Bureau, the State Survey was instrumental in obtaining the location of this laboratory at Beaufort and has always taken a keen interest in the work that is accomplished at the laboratory.

While a great deal of the work is perhaps purely of scientific interest, yet a great deal is accomplished through the laboratory that is of particular interest and value to the various fishing industries of the State. It was in coöperation with this laboratory that the State Survey was enabled to carry on its investigations relating to the cultivation of the oyster and terrapin, the results of which have already been published in Bulletins 14 and 15.

Another line of work that it is hoped can be undertaken in the near future is the study of the crab industry.

The report of the Commissioner of Fisheries regarding the Beaufort laboratory for the past fiscal year is as follows:*

"During the year this station was given some much needed repairs, the buildings were repainted, a new gasoline motor launch, with accommodations for extended trips, was provided, and the general equipment was increased and improved in a number of ways conducive to efficiency.

"In the preceding year a considerable accretion from harbor-dredging operations had been made to Pivers Island, on which the laboratory stands, and this material was regraded and fixed by planting grass and constructing windbreaks, with the result that the Bureau's property available for buildings and general purposes has been very materially increased.

"The experiments in diamond-back terrapin culture and the exploitation and location of the fishing grounds by the steamer *Fish Hawk* while detailed to the station have been mentioned elsewhere, with their attendant commercial results.

"The southern flounder, an excellent food fish, having been discovered in spawning condition, an experimental hatching apparatus was set up for use during the spring of 1914, but no ripe fish could be obtained. It is purposed to continue the experiments with the flounder and other commercial fishes, and, if possible, to utilize the plant as a fish hatchery, particularly when its other activities are at a minimum.

"During the summer of 1913 the methods of the scientific work of the station were partially reorganized so as to bring them into closer accord with the other activities of the Bureau. The researches have been more

*Ibid. Pages 68-69.

closely coördinated, so as to attack the several problems from various sides simultaneously, and utilize more advantageously and with less effort the facilities and material available.

"Special attention was paid to the collection and classification of data relating to fishes, their distribution in the region, their movements, food, enemies, spawning, and growth. Complete records were obtained of the time of spawning and the embryological and larval growth of two species, and incomplete histories of six others. To secure data for legislative purposes, critical studies of the rate of growth of fishes and the relations of weight to size at different ages were undertaken, and the work on the determination of the ages and other facts of the life histories of fishes, as revealed by the scale markings, was continued from the preceding year. These latter researches offer a most promising means for revealing facts, a knowledge of which is necessarily antecedent to effective measures for fisheries conservation. The study of the food and feeding of fishes was undertaken by several investigators, each studying a special group of organisms. Interesting results were obtained from experiments to determine the extent and character of the flounder's adaptation of its color to its environment, and the work will be continued to establish to what extent the color modifications serve as a protection to the fish.

"The edible crab supply is apparently becoming depleted, but its habits are not sufficiently well known to make it possible to propose conservative measures without danger of unnecessarily injuring the fishery. To endeavor to supply part of the needed information, a temporary assistant began studies and experiments during the year.

"For several summers tests have been conducted at the laboratory to determine the feasibility of protecting wood from marine borers by impregnating it with solutions of metals and other substances. At the end of the fiscal year coöperative arrangements were established with the Forest Service for the further prosecution of the work.

"Owing to delay in passage of the annual appropriation bill, the operations of the laboratory near the end of the fiscal year were seriously interfered with by uncertainty as to funds for the continuance of such work as might be begun."

UNITED STATES COAST AND GEODETIC SURVEY.

MARKING RESTRICTED AREAS.

When it became necessary to mark by buoys the restricted areas in which fishing was prohibited, it was found that the State Survey was not in a position to do this work, and at the request of the Fish Commis-

sioner and State Geologist the United States Coast and Geodetic Survey coöperated with the State in surveying and buoying these restricted areas. Portions of this work have to be repeated from time to time as the buoys become misplaced. During 1913 the Coast and Geodetic Survey assisted the State in making a resurvey of a considerable portion of the restricted areas, and the result of the work done is given in the following report:

November 28, 1913.

REPORT OF THE SURVEY MADE FOR THE NORTH CAROLINA FISH COMMISSION IN ALBEMARLE, CROATAN, AND PAMLICO SOUNDS, NORTH CAROLINA, OCTOBER 28 TO NOVEMBER 20, 1913.

CLEM L. GARNER, *Assistant, C. and G. Survey, Chief of Party.*

SIR:—I have the honor to submit the following report of the work executed for the North Carolina Fish Commission in accordance with your instructions dated September 18, 1913.

The work consisted in the replacing of buoys to mark the fishing limits of Albemarle, Croatan, and Pamlico sounds as prescribed by acts of the General Assembly of North Carolina in 1909. Also buoys still existing from former surveys were relocated when in any case there was evidence that the position had changed.

Due to all preliminary arrangements for this work being done by Mr. J. H. Leroy, Fish Commissioner of Elizabeth City, N. C., it was not necessary that I leave the office until the last part of October.

I left Washington October 26 p. m., and arrived in Elizabeth City the next day, where I was met by the Fish Commissioner. He was ready to go over to Manteo with me the same day, and preparations for the work were immediately begun. Headquarters were immediately established at Manteo, N. C., and on October 28 the launch, which had been previously prepared for the work, was looked over and all necessary equipment put in order for work the next day.

In consulting with the Fish Commissioner, Mr. J. H. Leroy, it was decided to start work to the north of Durant's Island, since that territory was where the marks had partly disappeared and where the fishermen were least disposed to obey the law. Here old stakes showing the position of last season's pound nets were 200 to 400 yards beyond the limits. Another reason for beginning the work here was to take advantage of the good weather and not leave for the last a place open to the northerly and predominant winds during this season of the year. In this way work could be done to the south of Roanoke Island and south of Stumpy Point when the northerly winds prevented work in the vicinity of Durant's Island.

Another thing decided upon with the Fish Commissioner was that with the limited funds at hand to direct it to these areas in question with the view to keep an open channel for navigation; to keep an open passage for the fish from the inlets to the various bodies of water in that region, and to mark out those areas most in dispute and least regarded by the fishermen.

Field work was started October 29th, but little was accomplished on account of unfavorable weather. October 30th was a good day, and four buoys were placed in Croatan Sound, marking the area limited to dutch- or pound-

net fishing. From this the work was directed to the vicinity of Durant's Island and then carried southward, replacing buoys Nos. 6 to 11, 13 to 23, 32, 36, 37, 38, 40 to 43, 45, 48, 50, 150, 157, 158, and 160. Buoys Nos. 151, 152, 153, 154, 155, 159, and 47 were relocated and Nos. 161 and 162 were placed originally. These last two were placed on account of the larger amount of fishing which is now being done in the east side of Croatan Sound, and they mark the area which the Fish Commissioner requested to have marked.

Positions Nos. 33, 34, 35, 39, and 49 were marked with stakes, the water being very shallow and not suitable for buoys. These were sunk in the bottom far enough to make them permanent marks until they are eaten by the worms. Position No. 39 was intended for a buoy, but on the last day of work in this vicinity it was not possible to place the buoy on account of darkness. Plans had been made for running to Elizabeth City the next day, and to return to the south end of the island to place this one buoy would have been useless expense. The Fish Commissioner informed me that he intended doing some work in this vicinity very soon, and that he would gladly place the buoy in the position as marked by the stake. Thereupon this one buoy was left for him to place.

The entire number of marks placed during this survey show the limits as prescribed by law for dutch- or pound-net fishing. Those placed to mark the restricted area at Oregon Inlet also mark the area in which any kind of fishing is prohibited. The laws most violated are those covering the dutch- or pound-net fishing, and consequently those areas were of first importance.

The laws in so far as they relate to these parts of Albemarle, Croatan, and Pamlico sounds have not changed since 1911, when the survey last before this was made, and consequently the present work concerned only the replacing of buoys in positions as shown by the last defined limits. As pointed out in Assistant Steirnegle's report of January, 1912, there are several inconsistencies in the law, especially notable of which are those covering the limits at Caroon's Point and at Roanoke Marshes Lighthouse. At these places the buoys were placed in the positions as decided upon that year.

Buoy No. 47, established by Assistant Rude in 1909, was found about 250 meters to the northwest of the original position, but only a small part of it now stands above the water, and it is likely that it will soon disappear entirely.

A comparatively small number of buoys that were previously placed are existing now. All of these were relocated and examined as to their condition, and when bad, new ones were placed in the position. Only in a few instances were the buoys found to be moved from the proper positions, and this seems to have been caused by the ice during the winter seasons instead of by the fishermen, as some have supposed. It is probable that the buoys were entirely destroyed when in any case they were disturbed. Of the buoys found as above mentioned, the larger number were those placed by Assistant Steirnegle in 1911. Of thirty-two buoys which were placed by him, only eight were existing at the time of this survey, and two of these were not fit for longer use. An examination showed that these were "honeycombed" by the *toredo* and were completely water-logged.

From this it seems that the age of the average juniper buoy when painted is from one and one-half to three years, depending on the class of juniper

and whether in the vicinity of an outlet from a fresh-water stream or not. The worm does not live in fresh water. Until a means is devised to increase the lives of the buoys it will continue to be a large expense in maintaining a number sufficient to adequately mark the fishing limits.

Several old signals were found standing in the vicinity to the north of Roanoke Marshes Lighthouse, and some of them were in fair condition and will stand probably a year or more. There were no signals standing south of Roanoke Marshes Light. They have apparently been cut down and no signals of a permanent character were built to replace them.

On November 20 the work was brought to a close, thirty-four buoys having been placed, seven buoys relocated, five stakes placed, and a number of signals repaired. On November 19 the instruments were packed and everything put in readiness to leave for Elizabeth City the next day in the State launch, *Gretchen*. From Elizabeth City I at once left for Washington.

The work was facilitated in many ways by the coöperation of the Fish Commissioner, favorable weather, and a crew congenial to the work.

Referring to buoy No. 24, known as the "ten-mile buoy," that was not visited, but all of the ranges are reported to be standing, and its position can be fixed by the Commission. With that located, it seems that any person caring to obey the law could fish in that vicinity without exceeding the limits a reasonable amount.

All positions determined were with sextant and protractor except to the southwest of Long Shoal Point, where two short bases were measured. Here the direction of the buoy from one end of the base being decided upon, the angle between the base and the line to the buoy being measured, the other parts of the triangle were computed. A sensitive range was established on one of the lines from the base to the buoy and the launch was run in on this range until the angle, on the sextant, between the ends of the base was the same as the computed angle when the buoy was placed in the water.

I would especially recommend that the Fish Commission be impressed with the necessity of preserving the buoys, for that alone will in the aggregate reduce the expense of the surveys and afford a means of keeping the limits adequately marked. Creosoting or some other means of treating the buoys to keep the worms out, even though making the initial expense larger, would in the end be much more economical both to the State and to the National Government. The sinkers made of concrete last, or can be made to last, indefinitely, and by taking up the buoys once a year, or when needed, for repainting and repairing, the expense would practically be reduced to the cost of the launch and crew and repairs. The launch could easily be fitted to take up and replace ten or fifteen buoys in a day of fairly good weather, and in this way the position of the buoys would not be lost. Of course, in this way it would be necessary in the beginning to purchase a number of extra buoys, but it is believed that the economy in the end would prove this to be the cheaper.

The records pertaining to this work are included in one volume of Angles which are transmitted separately and a tracing and blue-print, the legend of which shows the buoys replaced and relocated. A blue-print is also transmitted with this report.

The compiled laws of North Carolina pertaining to fishing and fisheries as previously printed in pamphlet form are exhausted, and, therefore, are not transmitted herewith. There have been few changes since the work of 1911. Assistant Steirnegle transmitted those laws with his report.

In closing I wish to thank Mr. J. H. Leroy, Fish Commissioner, for his hearty coöperation in the work and for his personal assistance rendered in many instances.

Respectfully submitted,

CLEM L. GARNER,
Assistant, C. and G. Survey.

To the SUPERINTENDENT,
Coast and Geodetic Survey,
Washington, D. C.

SPECIAL ACT OF CONGRESS.

As stated in the Biennial Report of the State Geologist for 1911-1912, an act has already been passed by Congress authorizing the coöperation of the United States Bureau of Fisheries and the United States Coast and Geodetic Survey with the North Carolina Fisheries Commission in locating and marking restricted fishing areas, and we have every reason to believe that if the Fisheries Commission bill is passed by the General Assembly of North Carolina, giving the State jurisdiction over all commercial fisheries, that Congress will make adequate appropriations to the Federal bureaus mentioned above to enable them to carry out the coöperative work by the act referred to.

FISH CULTURAL STATIONS.

The United States Bureau of Fisheries has established at Edenton, Chowan County, a fish hatchery whose chief work is the hatching of shad eggs. This station has undoubtedly been one of the chief means of maintaining the shad industry in North Carolina.

Since the creation of the Fish Commission the hatchery has been able to obtain a constantly increasing supply of ripe eggs, which are all obtained at the upper end of Albemarle Sound. The ripe fish that are taken there are on their way from the sea to the spawning grounds.

The benefits to be derived from this hatchery are at the present time confined almost entirely to what is known as the "Albemarle Region." The United States Bureau of Fisheries, with the approval of the Secretary of Commerce, has adopted a policy which precludes the planting of fish from the Edenton hatchery in waters of the State that are not under the jurisdiction of the North Carolina Fish Commission. This position of the Bureau is just, for it would not be fair to the State, or to the fishermen of the Albemarle region and contiguous waters, to divert the output of the Edenton hatchery to waters of the State where the

fishermen are not in sympathy with the legislation that is necessary to protect and conserve the fisheries. Both the Secretary of Commerce and the Commissioner of the Bureau of Fisheries have expressed themselves as being desirous to undertake more extensive fish cultural work throughout North Carolina as soon as those portions of the State now outside the jurisdiction of the Fish Commission come under its provisions.

We have every reason to believe that if the Fisheries Commission is established for North Carolina, the United States Bureau of Fisheries will recommend the establishment of a shad hatchery on some of the rivers leading into Pamlico Sound, and the placing of a floating hatchery in the Cape Fear River. Other phases of this cultural work will also be undertaken.

The above expressions from the United States Bureau of Fisheries emphasize the need of the Fisheries Commission to have charge and supervision of the fisheries of the State.

SUGGESTED FISHERIES LEGISLATION.

With a few modifications, I am recommending to the General Assembly of 1915 the same fisheries legislation that I recommended in my Biennial Report of 1911-1912. As is seen from the statement of Dr. Hugh M. Smith, Commissioner of the United States Bureau of Fisheries, he concurs in the opinion that the passage of either the legislation suggested or some similar legislation is absolutely necessary for the preservation of the fishing industry in this State. With its passage there is no doubt but that the value of the fishery industry of the State can be multiplied several fold.

The legislation suggested is as follows:

A BILL TO BE ENTITLED AN ACT TO ESTABLISH A FISHERIES COMMISSION AND TO PROTECT THE FISHERIES OF NORTH CAROLINA.

The General Assembly of North Carolina do enact:

SECTION 1. That for the purpose of enforcing the laws relating to all commercial fish there is hereby created a Fisheries Commission, which shall consist of five members appointed by the Governor, at least three of whom shall be from the several fishing districts of the State, who shall be denominated the "Fisheries Commission Board." The members shall be appointed as follows, viz.: two, whose terms of office shall expire on the first day of June, one thousand nine hundred and seventeen, and three whose terms of office shall expire on the first day of June, one thousand nine hundred and nineteen; and their successors shall be appointed by the Governor for a term of four years each thereafter. The members shall receive four dollars per day each and traveling expenses while attending meetings of the board: *Provided*, that the per diem and expenses shall not exceed two hundred and fifty dollars each per annum.

That said board shall appoint a Fish Commissioner within thirty days after the passage of this act, and the said commissioner shall be responsible to the Fisheries Commission Board for carrying out the duties of his office, and shall make semiannual reports to them at such time as they may require. The term of office of said commissioner and his successors in office shall be four years, or until their successors are appointed and qualified, and in case of vacancy in the office the appointment shall be to fill the vacancy. The said commissioner shall appoint two assistant commissioners, by and with the consent of the Fisheries Commission Board, one of whom shall be designated as Assistant Fish Commissioner and the other as Shellfish Commissioner. The aforesaid commissioner and assistant commissioners shall receive such pay as the Fisheries Commission Board shall determine. During the absence of the commissioner, or his inability to act, the Fisheries Commission Board shall appoint one of the assistant commissioners to have and exercise all the powers of the commissioner. The commissioner and assistant commissioners shall each execute and file with the Secretary of State a bond, payable to the State of North Carolina, in the sum of five thousand dollars for the commissioner and twenty-five hundred dollars for each of the assistant commissioners, with sureties to be approved by the Secretary of State, conditioned for the faithful performance of their duties and to account for and pay over pursuant to law all moneys received by them in their office. The Fisheries Commissioner and assistant commissioners shall take and subscribe an oath to support the Constitution and for the faithful performance of the duties of his office, which oaths shall be filed with their bonds. The assistant commissioners may be removed for cause by the commissioner, who may appoint their successors.

Sec. 2. *Inspectors.*—The Fisheries Commissioner may appoint, with the approval of the Fisheries Commission Board, inspectors in each county having fisheries under his jurisdiction, who will assist him at such times as he may require. The said inspector shall serve under the direction of the commissioner, receiving compensation not to exceed three dollars per day and necessary expenses while in actual service.

Sec. 3. *Office and Clerical Force.*—The Fisheries Commissioner shall rent and equip an office, which will be adequate for the business of the commission, in some town conveniently located to the maritime fisheries, and he is authorized to employ such clerks and other employees as may be necessary for the proper carrying on of the work of his office, by and with the consent of the Fisheries Commission Board.

Sec. 4. *Equipment.*—The Fisheries Commissioner is authorized, by and with the consent of the Fisheries Commission Board, to purchase or rent such boats, nets, and other equipment as may be necessary to enable him and his assistants to fulfill the duties specified in this act.

Sec. 5. *Duties.*—The commissioner shall enforce all acts relating to the fish and fisheries of North Carolina; he shall, by and with the advice and consent of the Fisheries Commission Board, make such regulations as shall maintain open for the passage of fishes all inlets and not less than one-third of the width of all sounds and streams, or such greater proportions of their width as may be necessary; he shall collect and compile statistics showing the annual product of the fisheries of the State, the capital invested and the

apparatus employed, and any fisherman refusing to give these statistics shall be refused a license for the next year; and the Fish Commissioner shall prepare and have on file in his office maps based on the charts of the United States Coast and Geodetic Survey, of the largest scale published, showing as closely as may be the location of all fixed apparatus employed during each fishing season; he shall have surveyed and marked in a prominent manner those areas of waters of the State in which the use of any or all fishing appliances are prohibited by law or regulation, and those areas of waters in the State in which oyster tonging or dredging is prohibited by law; he shall prosecute all violations of the fish laws, and whenever necessary he may employ counsel for this purpose; wherever he shall find nets or other appliances being fished or used in violation of the fisheries laws of the State he shall remove same pending trial; he shall, in an official capacity, have power to administer oaths and to send for and examine persons and papers; he shall be responsible for the collection of all license fees, taxes, rentals, or other imposts on the fisheries, and shall pay same into the State Treasury to the credit of the Fisheries Commission fund; he shall, on or before the twenty-fifth day of each month, mail to the Treasurer of the State a consolidated statement showing the amount of taxes and license fees collected during the preceding month, and by and from whom collected; he shall carry on investigations relating to the migration and habits of the fish in the waters of the State, also investigations relating to the cultivation of the oyster, clam, and other mollusca, and of the terrapin, lobster, and crab, and for this purpose he may employ such scientific assistance as may be authorized by the Fisheries Commission Board.

Sec. 6. *Arrests Without Warrant; When and How Made.*—The Fisheries Commissioner, assistant commissioners and inspectors shall have power, with or without warrants, to arrest any person or persons violating any of the fishery laws, who shall be carried before a magistrate for trial according to section three thousand one hundred and eighty-two of the Revisal of one thousand nine hundred and five.

Sec. 7. *Power to Take Fish.*—The Fisheries Commissioner and the United States Bureau of Fisheries may take and cause to be taken for scientific purposes, or for fish culture, any fish or other marine organism at any time from the waters of North Carolina, any law to the contrary notwithstanding; and may cause or permit to be sold such fishes or parts of fishes so taken as may not be necessary for purposes of scientific investigations or fish culture: *Provided*, that in taking fish for fish culture in the hatcheries of this State the fish shall only be taken while the hatcheries are in operation and only between the hours of 4 and 11 p. m.

Sec. 8. *No Interest in Fisheries.*—The members of the Fisheries Commission Board, the Fisheries Commissioner, assistant commissioners, and inspectors shall not be financially interested in any fishing industry in North Carolina.

Sec. 9. *Revenue.*—All license fees, taxes, rentals of bottoms for oyster or clam cultivation and other imposts upon the fisheries, in whatever manner collected, shall, except as otherwise provided in this act, be deposited with the State Treasurer to the credit of the Fisheries Commission fund, to be drawn upon as directed by the Fisheries Commission Board.

SEC. 10. *License to Fish and to Catch Oysters.*—Each and every person, firm, or corporation, before commencing or engaging in any kind of fishing in the State, shall file with an inspector of the county in which he desires to fish, or with the Fisheries Commissioner or one of his assistant commissioners, a sworn statement as to the number and kind of nets, seines, or other apparatus intended to be used in fishing. Upon filing this sworn statement on oath the Fisheries Commissioner shall issue or cause to be issued to the said party or parties a license as prescribed by law; said applicant shall pay a license fee equal in amount to the fee or tax prescribed by law for fishing different kinds of apparatus in the waters of the State of North Carolina, or for tonging or dredging for oysters, as the case may be. The Fisheries Commissioner shall keep in a book especially prepared for the purpose an exact record of all licenses, to whom issued, the number and kinds of nets, boats, and other apparatus licensed, and the license fees received. He shall furnish to each person, firm, or corporation in whose favor a license is issued a special tag which will show the license number and number of pound nets, or yards of seine, or yards of gill net that the licensee is authorized to use, and the licensee shall attach said tag to the net in a conspicuous manner satisfactory to the Fisheries Commissioner. All boats or vessels licensed to scoop, scrape, or dredge oysters shall display on the port side of the jib, above the reef and bonnet and on the opposite side of mainsail, above all reef points, in black letters, not less than twenty inches long, the initial letter of the county granting the license and the number of said license, the number to be painted on canvas and furnished by the Fisheries Commissioner, for which he shall receive the sum of fifty cents. Any boat or vessel used in catching oysters without having complied with the provisions of this section may be seized, forfeited, advertised for twenty days at the courthouse and two other public places in the county where seized, and sold at some public place designated in the advertisement, and the proceeds, less the cost of the proceedings, shall be paid into the school fund. The licenses to fish with nets shall all terminate on December thirty-first. Any person who shall willfully use for commercial fishing purposes any kind of net whatever, without having first complied with the provisions of this section, shall be guilty of a misdemeanor and, upon conviction, shall be fined twenty-five dollars for each and every offense.

SEC. 11. *License for Boat Used in Catching Oysters.*—The Fisheries Commissioner, or Shellfish Commissioner, or inspector, may grant license for a boat to be used in catching oysters upon application made, according to law, and the payment of a license tax as follows: On any boat or vessel without cabin or deck, and under custom house tonnage, using scoops, scrapes, or dredges, measuring over all twenty-five feet and under thirty, a tax of three dollars; fifteen feet and under twenty-five feet, a tax of two dollars; on any boat or vessel with cabin or deck and under custom house tonnage, using scrapes or dredges, measuring over all thirty feet or under, a tax of five dollars; over thirty feet, a tax of six dollars; on any boat or vessel using scoops, scrapes, or dredges required to be registered or enrolled in the custom house, a tax of one dollar and fifty cents a ton on gross tonnage. No vessel propelled by steam, gas, or electricity, and no boat or vessel not the property absolutely of a citizen or citizens of this State, shall receive license or be

permitted in any manner to engage in the catching of oysters anywhere in the waters of this State.

SEC. 12. *Fishing for Menhaden With Purse Nets.*—Whenever any person or persons, corporation or corporations, may intend to take menhaden (fat-backs), porgies, herring, or other fish in any waters within the jurisdiction of this State, including the waters of the Atlantic Ocean within three nautical miles of the coasts of said State, either on his own account and benefit or on account and benefit of his employer, with purse or shirred nets, such person or persons, corporation or corporations, shall make an application to the Fisheries Commissioner for a license, and, upon the receipt of such application, the Fisheries Commissioner shall, upon the receipt of a sum equal to two dollars for each ton of the net tonnage of each vessel employed in such fishing, said net tonnage to be determined by custom house measurement, as a license fee, issue to such person or persons, corporation or corporations, a license duly signed by the Fisheries Commissioner, which said license shall be valid and in force for the term of one year; all such licenses to be dated from January first, and no license shall be for a space of time less than one year. For every violation of this act the offending person or persons, corporation or corporations, shall be guilty of a misdemeanor and be fined two hundred dollars for each and every offense.

SEC. 13. *Purchase Tax.*—All dealers in oysters and all persons who purchase oysters for canning, packing, shucking, or shipping, shall pay a tax of two cents on every bushel of oysters purchased by them, or caught by them, or by any one for them: *Provided*, that no oyster shall be twice taxed. This tax shall be paid to and collected by the inspectors, and, when paid, a receipt shall be given therefor. Upon failure or refusal by any person, firm, or corporation to pay said tax, his license as a dealer shall at once become null and void, and no further license shall be granted him during the current year; and it shall be the duty of the commissioner, assistant commissioner, or inspector to institute suit for the collection of said tax. Such suit shall be in the name of the State of North Carolina on relation of the commissioner or of the inspector at whose instance such suit is instituted, and the recovery shall be for the benefit and to the use of the general Fisheries Commission fund.

SEC. 14. *License Tax.*—The following license tax is hereby levied annually upon the different fishing appliances used in the waters of North Carolina:

Anchor gill nets, twenty cents per one hundred yards or fraction thereof.

Stake gill nets, ten cents per one hundred yards or fraction thereof.

Drift gill nets, twenty cents per one hundred yards or fraction thereof.

Pound nets, one dollar each.

Seine, drag nets, and mullet nets under one hundred yards, one dollar each.

Seine, drag nets, and mullet nets over one hundred yards and under three hundred yards, one dollar per one hundred yards or fraction thereof.

Seine, drag nets, and mullet nets over three hundred yards and under one thousand yards, one dollar and twenty-five cents per one hundred yards or fraction thereof.

Seine, drag nets, and mullet nets over one thousand yards, one dollar and seventy-five cents per one hundred yards or fraction thereof.

Fyke nets, twenty-five cents each.

Tonging for oysters, the license tax shall be one dollar for each tonger.

SEC. 15. *Reports.*—The Fisheries Commission Board shall cause to be prepared and submitted to each Legislature a report showing the operations, collections and expenditures of the Fisheries Commission; it shall also cause to be prepared for publication such other reports, with necessary illustrations and maps, as will adequately set forth the results of the work and the investigations of the Fisheries Commission, all such reports, illustrations, and maps to be printed and distributed at the expense of the State, as are other public documents, as the Fisheries Commission Board may direct.

SEC. 16. *Appropriation.*—There is hereby appropriated out of the General Treasury as a supplementary fund the sum of ten thousand dollars annually for four years, or as much thereof as may be needed, to the Fisheries Commission to carry out the work of the commission in the protection and promotion of the fisheries of the State, this sum to be repaid to the General Treasury by the Fisheries Commission when it shall be on a self-sustaining basis, said sum to be used and expended as directed by the Fisheries Commission Board, and any part of it that may be required may be used for purchasing boats and other equipment necessary to carry out the work of the Commission; and any money that may be in the State Treasury to the credit of the Fish Commission and Oyster Commission fund on the day that this act becomes effective shall be transferred by the State Treasurer to the credit of the Fisheries Commission fund, and the Fisheries Commission Board is hereby authorized to pay out of the Fisheries Commission fund all just claims that may be outstanding against the Fish or Oyster Commissions.

SEC. 17. *Transfer of Equipment.*—All boats, fishing and oyster tackle, office supplies, stationery, and all other supplies of whatever character belonging to the Fish Commission and Oyster Commission shall be transferred to the Fisheries Commissioner for the use of the Fisheries Commission.

SEC. 18. *Jurisdiction of State.*—The State of North Carolina shall have exclusive jurisdiction and control over all the commercial fisheries of the State wherever located.

SEC. 19. It shall be unlawful to place in any of the waters of this State any dynamite, giant or electric powder, or any explosive substance whatever, or any drug or poisoned bait, for the purpose of taking, killing, or injuring fish. And any one violating this section shall, upon conviction, be fined not less than one hundred dollars and imprisoned not less than thirty days.

SEC. 20. It shall be unlawful to discharge or to cause or permit to be discharged into the waters of the State any deleterious or poisonous substance or substances inimical to the fishes inhabiting the said waters; and any person, persons or corporation violating the provisions of this section shall be guilty of a misdemeanor and, upon conviction, be fined or imprisoned, in the discretion of the court.

SEC. 21. The Fisheries Commission Board is hereby authorized to regulate, prohibit, or restrict, in time, place, character, and dimensions, the use of nets, appliances, apparatus, or means employed in taking or killing fish; to regulate the seasons at which the various species of fish may be taken in the several waters of the State, and to prescribe the minimum sizes of fish which may be taken in the said several waters of the State; and such regulations, prohibitions, restrictions and prescriptions, after due publication, shall be of equal

force and effect with the provisions of this act; and any person violating the provisions of this section shall be guilty of a misdemeanor, and upon conviction shall be fined or imprisoned at the discretion of the court: *Provided, however*, that if a petition signed by five or more voters of the district or community which will be affected by the proposed change is filed with the Fisheries Commission Board through the Fisheries Commissioner, assistant commissioners, or inspectors, asking that they have a hearing before any proposed change in the territory, size of mesh, length of net, or time of fishing shall go into effect, petitioning that they be heard regarding said change, the Fisheries Commission Board shall in that event designate by advertisement for a period of thirty days at the courthouse and three other public places in the county affected, and also by publication in a newspaper of the county, if such is published in said county, for two consecutive weeks, the place at which said board will meet and hear argument for and against said change, and may ratify, rescind, or alter this previous order of change as may seem just in the premises; and *Provided further*, that in making regulations the Fisheries Commission Board shall give due weight and consideration to all factors which will affect the value of the present investment in the fisheries, and that no changes in the existing laws which, if they should go into effect immediately, would tend to cause fishermen to lose their property shall go into effect until twelve months from the date that the change has been made by the Fisheries Commission Board.

Sec. 22. Any person or persons removing, injuring, defacing, or in any way disturbing the posts, buoys, or any other appliances used by the Fisheries Commission in marking the restricted areas relating to any and all fishing, or marking other areas in which oyster tonging or dredging is prohibited by law, and those marking oyster bottoms that are leased for oyster cultivation, shall be guilty of a misdemeanor and, upon conviction, shall be fined or imprisoned at the discretion of the court; and any person anchoring or mooring a boat to any of these buoys or posts shall, upon conviction, be fined not less than twenty-five or more than one hundred dollars and imprisoned thirty days in jail at the discretion of the court.

Sec. 23. Wherever the word fish or fishes used as a substantive occurs in this act it shall be construed to include porpoises and other marine mammals, fishes, mollusca, and crustaceans, and wherever the word fishing or fisheries occurs it shall be construed to include all operations involved in using, setting, or operating apparatus employed in killing or taking the said animals or in transporting and preparing them for market.

Sec. 24. That all acts relating to the commercial fisheries of North Carolina are hereby amended so that the words "Shellfish Commissioner," "Oyster Commissioner," or "Fish Commissioner" shall read "*Fisheries Commissioner*"; and the words "Shellfish Commission," "Oyster Commission," or "Fish Commission" shall read "*Fisheries Commission.*"

Sec. 25. All laws and clauses of laws in conflict with this act are hereby repealed.

Sec. 26. That this act shall be in force from and after its ratification.

EXHIBITS AT EXPOSITIONS AND STATE FAIRS.

During the fiscal years 1913-1914 the North Carolina Geological and Economic Survey made an exhibit at the National Conservation Exposition, at Knoxville, Tennessee, during September and October, 1913.

The Survey also made exhibits at the annual State Fairs at Raleigh in October, 1913, and also in October, 1914.

EXHIBIT AT NATIONAL CONSERVATION EXPOSITION.

The National Conservation Exposition, which was held in Knoxville, Tennessee, September 1 to October 21, 1913, had for its object "as complete a display of the natural resources of the country, especially of the South, as can be provided. In a broad way the design is to illustrate the ways in which natural wealth in forests, lands, waters, minerals, and human efficiency are now used and may be still used in protecting the prosperity and assuring the perpetuity of the American people."

The North Carolina Geological and Economic Survey was called upon to make an exhibit of the mineral and forestry resources of this State, and although the funds available for such an exhibit were very limited, yet the Survey was able through the hearty coöperation of mineral producers and lumber companies in the State to have a most creditable exhibit of North Carolina's commercial minerals and building stones, as well as forestry products. The details of the exhibit were as follows:

MINERAL EXHIBIT.

In the Mines Building North Carolina was allotted a space sixteen by forty feet for the display of her mineral resources. One of the principal features of the exhibit was a display of building stone. This exhibit was made possible through the hearty coöperation of the North Carolina Granite Corporation, who shipped for this exhibit sufficient curbing to outline the space, together with four granite posts or columns. This not only gave a very striking effect to the entire exhibit, but was a splendid advertisement for the gray granite, which is now becoming so well known the country over.

In addition to the gray granite, the Survey carried from the State Museum spheres of pink granite, white marble, and orbicular gabbro diorite or leopardite which were much admired and attracted a great deal of attention.

The mica resources of the State were well shown, and the exhibit sent by the Tar Heel Mica Company, of Plumtree, North Carolina, was very complete, showing the mica not only as it occurs in nature, but as it is cut and prepared for market.

The monazite display consisted of the crude sand, rough crystals; the monazite sand after being separated and its by-products; and a number of bottles of materials extracted from the thoria content of the monazite, this being donated by the Welsbach Light Company. This material is used by this company in the preparation of the incandescent mantles which they manufacture.

There was quite a display of pig iron and crude material from the famous Cranberry Iron Mines of Avery County, this being furnished by the Cranberry Furnace Company.

The famous North Carolina talc was well represented by an elaborate exhibit of the crude material and manufactured products furnished by the North Carolina Talc and Mining Company.

Mineral waters were exhibited by the Buckhorn Lithia Water Company of Henderson, who sent a case of water containing twelve and one-half bottles, and the Moores Mineral Springs Company, who sent a crate of two dozen bottles. This mineral water was very attractively displayed and was regarded with much interest.

A large specimen of gold ore was furnished by the Uwarra Mining Company, of Candor, Montgomery County, together with a blue-print of the mine.

The above mineral exhibits were donated to the Geological Survey. The exhibitors made small contributions toward the installation and care of exhibits and the Exposition Company paid transportation charges.

A collection of North Carolina gem minerals and abrasive minerals (garnet and corundum), together with other minerals of commercial importance in North Carolina, such as feldspar, barytes, kaolin, tin ore, copper ore, chromite, etc., were on display and attracted a great deal of attention and interest; also samples of many minerals which have been found within the State, but which have not assumed commercial importance.

The Survey also prepared a map giving localities of the various commercial minerals of North Carolina and exhibited many other maps of specific regions, giving detailed geology of these regions; and a map showing drainage areas, etc.

This exhibit was visited by a great many people from all sections of the country and about 3,500 names were recorded in a registry book.

FORESTRY EXHIBIT.

North Carolina had a small but creditable forestry exhibit at the National Conservation Exposition. The space allotted to our display was on the ground floor of the Land Building, surrounded by a large and very instructive forestry exhibit made by the United States Department of Agriculture.

Our exhibit was brought together through the interested coöperation of three or four public-spirited parties who, at their own expense, prepared artistic exhibits and shipped them direct to Knoxville in time to be installed by the Forester, who was there a day or two before the opening. The Exposition Company paid the carriage one way.

The Butters Lumber Company, of Boardman, North Carolina, sent a fine display of red-gum lumber manufactured into all kinds of interior finish. It illustrated not only the suitability of this wood for such purposes, but also the fact that it can be dried with no more warping than other woods are subject to. Samples of stained and varnished gum showed the value of this wood for decorative purposes.

The Biltmore Estate of Biltmore, North Carolina, supplied mounted cross-sections of young white pine trees of different ages, which had been planted on the estate. The rate of growth for this kind of pine in plantations was shown to be very rapid, a tree planted twenty-one years measuring thirteen and one-half inches in diameter two feet from the ground; one planted seventeen years, nine inches; one eleven years, five and one-half inches, and one planted six years was about three inches in diameter—all trees planted at about two years old.

The commercial value of white pine for planting in Western North Carolina was thus illustrated.

The Asheville Board of Trade contributed a collection of nine photographs of the city watershed, mounted in a frame on an easel, bearing the title "View of the 10,000-acre City-owned Watershed. Source of City's Pure Water Supply. Asheville, North Carolina." Included in this collection are photographs of the Craggies, Blackstocke Knob, Mount Mitchell, and other peaks which now, alas! are being denuded of their forest cover, which is so essential to the protection of the streams, by lumbering followed by fires.

The Champion Fiber Company, of Canton, North Carolina, which for many years has been experimenting with various native timbers to determine their value for paper-making, had a large and most instructive exhibit which was prepared, installed, and subsequently displayed and explained by a special agent of the manufacturers. Rolls of pulp of different grades and from various kinds of wood were shown, together with

their most important by-product, tannin extract. Of great interest were several pine products, turpentine, tar oil, wood acid, etc., which are being saved from the various species of pine now being successfully manufactured into pulp by this company.

At the close of the Exposition the exhibits of the Butters Lumber Company, the Biltmore Estate, and the Asheville Board of Trade were kindly donated to the Survey to be used by it for exhibition purposes as occasion offers.

EXHIBITS AT STATE FAIRS.

At the request of the secretary of the State Fair, the Survey has undertaken during the past two years to make such exhibits as was thought would be of educational value in connection with the State's natural resources and their conservation. The details of these exhibits are as follows:

State Fair of 1913.

This exhibit was located in Floral Hall and consisted of an exhibit of the principal mineral resources of the State, such as gold, copper, iron, corundum, chromite, tin minerals, mica, talc, gem minerals, monazite, graphite, etc. Minerals which were especially emphasized in this display were iron ores from Avery County furnished by the Cranberry Furnace Company, feldspar from Mitchell County furnished by the Carolina Mineral Company, and samples of common brick. Building stones were exhibited in the shape of curbing of gray granite from the North Carolina Granite Corporation and a large cube of blue pearl granite cut to show its monumental possibilities. Bags of shell marl were displayed, illustrating its value for agricultural purposes and its use as a chicken grit.

In addition to the minerals, there was displayed a series of samples of polished wood illustrating the timber resources and the furniture value of the lumber; photographs and maps showing the good roads of the State, and maps and illustrations of drainage districts.

State Fair of 1914.

The Survey had considerable correspondence with the mineral producers of the State in connection with the exhibit at the State Fair of 1914 in an effort to bring together a more complete exhibit and one of more value to visitors than any heretofore made. This effort met with a hearty response on the part of many of the mineral, stone, brick, and pottery producers, and the results were most gratifying.

The exhibit occupied a space twenty by twenty-four feet in the center of Machinery Hall. The space was outlined with gray granite curbing,

having pillars of the same material at each corner. This curbing was furnished by the North Carolina Granite Corporation, who have always given the Survey the most generous coöperation in all of its exhibits.

All of the chief mineral and gem collections used in the 1913 exhibit, and which were exhibited at Knoxville, were also included in this exhibit, with the following special features:

A mica exhibit from the Carolina Mineral Company from Mitchell County, which also included minerals and gems found associated with the mica, such as beryl, smoky quartz, topaz, and uranium; also an exhibit of feldspar from the same company.

Specimens of art pottery from the Nonconnah Art Pottery Company of Skyland, N. C. This exhibit attracted a great deal of attention and was visited and revisited by many people interested in this most artistic pottery product. North Carolina has the raw materials for the production of the very best pottery and china ware, and it is gratifying to note the growth of such an industry in the State.

Gold ore nuggets from the Coggins Mine, Montgomery County, and furnished by Mr. R. P. Richardson of the Rich Cog Mining Company; nickel ore and nickel matte furnished by the Consolidated Nickel Company, of Dillsboro, Jackson County; garnet suitable for abrasive purposes furnished by the Blue Ridge Granite Company, of Shooting Creek, Clay County, N. C.

Samples of shell marl showing its value for agricultural purposes and its use as chicken grit furnished by the Carolina Coast Lime Company of New Bern.

Samples of rhyolite suitable for macadam stone furnished by the Winston-Salem Southbound Railway Company.

In addition to the above, there were exhibits of talc by the North Carolina Talc and Mining Company; mica by the Tar Heel Mica Company at Plumtree; chromite, tin ore, kaolin, etc.

Another feature was quite a display of brick by the following: J. T. Fowler, Durham (two exhibits, one from Durham and one from Hillsboro); R. H. Clegg, Durham; Pamlico Brick and Tile Company, of Washington, N. C.; Tar River Brick Company, of Rocky Mount; samples of brick and of the material from which they were made by the Red Shale Brick Company, of Hot Springs, Madison County. This shale is of a good quality and makes a most excellent brick.

Another feature was an exhibit of road-building materials and road photographs by Mr. J. B. Roach, road engineer of Iredell County.

A series of road photographs from all over the State, collected by the Geological Survey; maps showing mineral localities, roads, drainage districts, etc.

Miss H. M. Berry stayed with the exhibit and gave to visitors information and data such as was desired in each case. It is believed that such an exhibit is not only of educational value to the people of our own State, but that it serves as a valuable advertisement of our natural resources to strangers who may happen to visit it.

PUBLICATIONS.

During the two years, 1913 and 1914, the following publications have been issued by the North Carolina Geological and Economic Survey, which embody the results of the investigations that have been outlined above and to which references have been made:

VOLUMES.

Volume IV. Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley, and H. H. Brimley. 1914.

BULLETINS.

24. Loblolly or North Carolina Pine, by W. W. Ashe. Prepared in coöperation with the U. S. Forest Service.

ECONOMIC PAPERS.

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 1913.

32. Public Roads Are Public Necessities, by Joseph Hyde Pratt, State Geologist. 1913.

33. Forest Fires in North Carolina During 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester. 1913.

34. Mining Industry in North Carolina During 1911-1912, by Joseph Hyde Pratt, State Geologist. 1914.

35. Good Roads Days, November 5 and 6, 1913. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 1914.

36. Proceedings of the North Carolina Good Roads Association held at Morehead City, N. C., July 31 and August 1, 1913, in coöperation with the North Carolina Geological and Economic Survey. Statistical Report of Highway Work in North Carolina During 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 1914.

37. Forest Fires in North Carolina During 1913, and a Summary of State Forest-fire Prevention in the United States, by J. S. Holmes, Forester. 1914.

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments, and Forms for Minutes of Board of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by George R. Boyd, Drainage Engineer. Contains North Carolina Drainage Law. 1914.

BIENNIAL REPORTS.

Biennial Report of the State Geologist, 1911-1912. Published 1913.

SPECIAL PUBLICATIONS.

Some Facts and Figures About North Carolina and Her Natural Resources. Prepared by the North Carolina Geological and Economic Survey. 1913.

Civic Days: Good Roads, Arbor Day. Compiled for use in the North Carolina Public Schools, November 6, 1913, in coöperation with the North Carolina Department of Education, by Miss H. M. Berry, Secretary, and J. S. Holmes, Forester.

GOOD ROADS CIRCULARS.

There have been published during this biennial period the following Good Roads Circulars. These have been written by the State Geologist, unless otherwise stated:

91. Necessity for State Aid in Road Work. May 1, 1913. 3 pp.

92. Bond Issues for Good Roads; Acts passed by the General Assembly of 1913 relating to bond issues for counties and townships for good roads construction. May 10, 1913. 22 pp.

93. Annual Meeting of the North Carolina Good Roads Association to be held at Morehead City July 31 and August 1, 1913. June 26, 1913. 2 pp.

94. Annual Convention of the North Carolina Good Roads Association to be held at Morehead City July 31 and August 1, 1913. July 25, 1913. 3 pp.

95. Status and Duties of the Road Engineer. August 25, 1913. 3 pp.

96. Fifth Annual Convention of the Southern Appalachian Good Roads Association, Asheville, N. C., October 22 and 23, 1913. October 14, 1913. 4 pp.

97. Economics of Convict Labor in Road Construction. February 18, 1914. 15 pp.

98. Organization of Road Forces (part of paper prepared for International Road Congress, held at London, England, June, 1913). March 2, 1914. 24 pp.

99. Use of the Abney Hand Level, by T. F. Hickerson. March 16, 1914. 6 pp.

100. Convention of the North Carolina Good Roads Association, Durham, July 9 and 10, 1914. June 11, 1914.

101. Decisions of the Supreme Court Regarding Road Bonds. June 25, 1914. 32 pp.

102. Annual Convention of the North Carolina Good Roads Association to be held at Durham, N. C., July 9 and 10, 1914. June 26, 1914. 4 pp.

103. State Highway Commission. July 8, 1914. 7 pp.

SPECIAL.

State Convicts on the Public Roads. September 15, 1913. 2 pp.

Suggestions for Organization and Work on Good Roads Days, November 5 and 6, 1915.

PRESS BULLETINS.

During the past two fiscal years Press Bulletins 94 to 136, inclusive, have been published and distributed by the North Carolina Geological and Economic Survey. These press bulletins discuss various questions relating to forestry, drainage, mining, etc., and have been issued in order to give to the people of the State a comprehensive idea of the work that the Survey is doing, and also in order to bring before the people at once certain information that the Survey has collected upon some particular subject. The press bulletins also call attention to the more detailed reports that the Survey is publishing as bulletins and economic papers. The newspapers quote freely from these press bulletins, and thus the information collected by the Survey is being given more general circulation.

The following is a list of the press bulletins published during the past two years:

94. Still Burning Up Money: Give the Pine a Chance; Important Legislation Foreshadowed. December 6, 1912. 1 p.

95. Live Stock and the Open Range in North Carolina. December 9, 1912. 1 p.

96. How to Protect and Perpetuate the Fishing Industries of North Carolina. December 11, 1912. 6 pp.

97. A State-wide Stock Law for North Carolina. December 20, 1912. 3 pp.

98. Fifth Annual Convention of the North Carolina Drainage Association. December 24, 1912. 3 pp.

99. The Third Annual Convention of the North Carolina Forestry Association, Raleigh, N. C., January 15, 1913. January 1, 1913. 2 pp.

100. Annual Meeting of the North Carolina Forestry Association. February 8, 1913. 5 pp.

101. Where Are the Robins? Our Deficit. February 27, 1913. 1 p.

102. Automobiles and Forestry. Important Forestry Meeting in Asheville. February 28, 1913. 1 p.

103. Eastern North Carolina and Its Drainage, by Walter Sharp. March 4, 1913. 2 pp.

104. Protecting the City Water Supply. The New Law. May 1, 1913. 1 p.

105. A Warning to Hunters. Forest-fire Damage Increasing. May 1, 1913. 1 p.

106. North Carolina Drainage Law (Codified). May 10, 1913. 26 pp.

107. A Forestry Exhibit at the National Conservation Exposition. June 7, 1913. 2 pp.

108. State Assistance to Owners of Woodlands. June 12, 1913. 4 pp.

109. Can Railroad Fires be Prevented? Spark Arresters on Railroad Locomotives. July 1, 1913. 3 pp.

110. Mineral Production in North Carolina During 1912. July 16, 1913. 2 pp.

111. Big Cold Water Creek Drainage District. August 14, 1913. 6 pp.

112. Fire Prevention and the Public Schools. October 25, 1913. 1 p.

113. Sixth Annual Convention of the North Carolina Drainage Association, to be Held in Charlotte, N. C., November 18-19, 1913. November 12, 1913. 4 pp.

114. Decisions of the Supreme Court Relating to Drainage Districts. January 26, 1914. 24 pp.

115. Timber Resources of Warren County. January 31, 1914. 4 pp.

116. Timber Resources of Orange County. January 31, 1914. 4 pp.

117. Timber Resources of Durham County. February 12, 1914. 4 pp.

118. Timber Resources of Randolph County. February 12, 1914. 4 pp.

119. Fourth Annual Convention of the North Carolina Forestry Association with the Appalachian Park Association, to be Held in Asheville, N. C., April 8-9, 1914. March 5, 1914. 3 pp.

120. Timber Resources of Guilford County. March 24, 1914. 4 pp.

121. Timber Resources of Alamance County. March 24, 1914. 4 pp.

122. Timber Resources of Caswell County. March 24, 1914. 4 pp.

123. Timber Resources of Vance County. March 24, 1914. 3 pp.

124. Timber Resources of Rockingham County. April 17, 1914. 4 pp.

125. Timber Resources of Person County. April 17, 1914. 4 pp.

126. Timber Resources of Granville County. April 17, 1914. 4 pp.

127. Decisions of the Supreme Court Regarding Drainage Districts. May 1, 1914. 35 pp.

128. Decision of the Supreme Court Relating to Drainage Work. July 10, 1914. 39 pp.

129. The North Carolina Forestry Association, Asheville Meeting. June 30, 1914. 8 pp.

130. A Forest Policy for North Carolina. July 10, 1914. 4 pp.

131. Children's Forestry Exhibits at County Fairs. September 21, 1914. 3 pp.

132. Mineral Production in North Carolina During 1913. October 1, 1914. 2 pp.

133. Preventing Erosion in Piedmont Drainage Districts. October 7, 1914. 5 pp.

134. Reclamation of the Swamp and Overflowed Lands of North Carolina. October 15, 1914. 6 pp.

135. Can Mount Mitchell's Spruce Forests be Saved? October 15, 1914. 4 pp.

136. Proceedings of Sixth Annual Drainage Convention Held under Auspices of the North Carolina Drainage Association, Charlotte, N. C., November 18 and 19, 1913. November 15, 1914. 14 pp.

ADDITIONAL PUBLICATIONS BY STATE GEOLOGIST.

In addition to the reports which the State Geologist has prepared for the State Survey, he has also published several articles in different magazines and papers throughout the country which have helped to advertise the natural resources of the State and its industrial advancement. The articles published during the past two years have been as follows:

PUBLICATIONS

BY

JOSEPH HYDE PRATT

December 1, 1912, to November 30, 1913.

1912.

Proceedings of the Convention of the Southern Appalachian Good Roads Association. Southern Good Roads, December, 1912.

1913.

New Occurrence of Monazite in North Carolina. Journal of the Elisha Mitchell Scientific Society, Vol. XXVIII, No. 4, February, 1913.

Convict Labor in Highway Construction. Better Roads, April, 1913.

Effect of Good and Bad Roads on Education in North Carolina. News and Observer, April 20, 1913.

Crest of the Blue Ridge Highway. Manufacturers Record, May 8, 1913.

Mount Airy Granite. Manufacturers Record, May 29, 1913.

Qualifications of Engineers and Surveyors in Charge of the Construction and Maintenance of Roads, Wages and Conditions of Service of Foreman and Roadmen. A paper prepared for the International Road Congress of London, England, June, 1913.

Eliminate the Weak Spots: A Plea for State Aid and Continuous Stretches of Good Roads. Sky-land, June, 1913.

The Highways of Western North Carolina. Southern Good Roads, July, 1913.

Mountain-to-Sea Highway. Sky-land, July, 1913.

The Bayley Street-paving Machine. Southern Good Roads, September, 1913.

A Tour Over the Central Highway. Sky-land, October, 1913.

Annual Address of the President of the National Association of Shellfish Commissioners, Norfolk, Virginia, April, 1913. Journal Elisha Mitchell Scientific Society, Vol. XXIX, No. 11, October, 1913.

Geological History of Western North Carolina. Journal Elisha Mitchell Scientific Society, Vol. XXIX, No. 11, October, 1913.

The Forests of North Carolina. Sky-land, October, 1913.

Some Impressions of the American Road Congress at Detroit, Michigan. Southern Good Roads, November, 1913.

1914.

The Annual Convention of the American Road Builders' Association. Southern Good Roads, Vol. IX, No. 1, January, 1914.

The Economics of Convict Labor in Road Construction. The State Journal, January 30, 1914; Good Roads Circular, No. 97, of the North Carolina Geological and Economic Survey; Better Roads.

Details of Arrangement and Organization of the Use of Convict Labor in Road Construction. Journal Elisha Mitchell Scientific Society, Vol. XXIX, No. 3, January, 1914.

Occurrence and Utilization of Certain Mineral Resources of the Southern States. Journal Elisha Mitchell Scientific Society, Vol. XXX, Nos. 1 and 2, June, 1914.

1914.

Sand-clay and Topsoil Roads for North Carolina. Southern Good Roads, Vol. IX, No. 6, June, 1914.

The Hickory Nut Gap Road. Southern Good Roads, Vol. IX, No. 6, June, 1914.

Central Highway in Madison County. Southern Good Roads, Vol. IX, No. 6, June, 1914.

Organization of Road Forces. (Part of paper prepared for International Road Congress held at London, England, June, 1913.) Good Roads Circular, No. 98, of North Carolina Geological and Economic Survey, March, 1914.

Centralized or General Control of Our Fisheries as Opposed to Local Control. The Oysterman and Fisherman, July 31, 1914.

A Forest Policy for North Carolina. Press Bulletin 130 of the North Carolina Geological and Economic Survey, July, 1914. Sky-land, August, 1914.

Sixth Annual Convention of the Southern Appalachian Good Roads Association. Southern Good Roads, Vol. X, No. 3, September, 1914.

North Carolina Drainage Law. Progressive Farmer, September 12, 1914.

Public Roads and Public Schools. Southern Good Roads, Vol. X, No. 4, October, 1914.

ADDRESSES OF STATE GEOLOGIST.

The State Geologist has been called upon to make addresses, not only in North Carolina, but before many National associations in different parts of the country. Most of the addresses outside of the State have had a direct bearing upon some problem relating to natural resources and applicable to conditions in North Carolina. There is given below a list of the addresses made by the State Geologist, together with the date and place:

A Fishery Policy for North Carolina. Address before North Carolina Fisheries Association at Washington, N. C., December 3, 1912.

A New Occurrence of Monazite in North Carolina. A paper read before the Geological Society of America, New Haven, Conn., December 30, 1912.

Bond Issue for Road Building in Person County. Address at Roxboro, N. C., January 1, 1913.

Necessity of Engineering Supervision in Road Construction. Address at Sanford, N. C., January 7, 1913.

The Weeks Law. Address before North Carolina Forestry Association, Raleigh, N. C., January 16, 1913.

County Road Legislation. Address at Lumberton, N. C., January 18, 1913.

Central Highway in North Carolina. Address before Southern Transcontinental Highway Association, Asheville, N. C., February 12, 1913.

Bond Issues for Road Building. Address at Lexington, N. C., February 25, 1913.

Bond Issues for Road Building. Address at Thomasville, N. C., February 25, 1913.

Crest of the Blue Ridge Highway. Address before Federal Aid Congress, Washington, D. C., March 6, 1913.

The Hickory Nut Gap Highway. Address at Bat Cave, March 31, 1913.

County Road Work. Address at Rutherfordton, N. C., April 7, 1913.

Drainage of Swamp Lands of the Southern States. Address before National Drainage Congress, St. Louis, Mo., April 9, 1913.

Bond Issues for Road Construction. Address at two schoolhouses in Davidson County, N. C., April 17, 1913.

County Bond Issue for Road Construction. Address at Henderson, N. C., April 19, 1913.

President's Address. Before the National Association of Shellfish Commissioners, Norfolk, Va., April 23, 1913.

County Bond Issues for Road Construction. Address at Tarboro, N. C., June 6, 1913.

Natural Resources of North Carolina. Address before University Summer School, Chapel Hill, N. C., June 17, 1913.

Maintenance of Roads. Address at Hickory, N. C., June 28, 1913.

The North Carolina Highway Commission. Address before the annual convention of the North Carolina Good Roads Association, Morehead City, N. C., July 31, 1913.

County Bond Issue for Road Construction. Address at Holly Springs, N. C., August 6, 1913.

County Road Work. Address before annual meeting of the North Carolina Association of County Commissioners at Statesville, N. C., August 13, 1913.

Tri-County Highway. Address at Denton, N. C., September 8, 1913.

Street Pavements. Address before Chamber of Commerce, Raleigh, N. C., September 9, 1913.

Bond Issue for Building Roads. Address at Littleton, N. C., September 12, 1913.

Bond Issue for Building Roads. Address at Norlina, N. C., September 13, 1913.

Conservation of Nonmetallic Minerals. Address before meeting of State Geologists at Knoxville, Tenn., September 19, 1913.

State Highway Commission. Address before special meeting of North Carolina Good Roads Association, at Raleigh, N. C., September 24, 1913.

Bond Issue for Road Construction. Address at Granite Falls, N. C., September 26, 1913.

Convict Labor and Road Building. Address before American Road Congress, Detroit, Mich., October 1, 1913.

Road Work in the Southern Appalachian Region. Address before the Southern Appalachian Good Roads Association, Asheville, N. C., October 21, 1913.

Road Maintenance. Address at Asheville, N. C., November 7, 1913.

County Road Work. Talk at Marshall, N. C., November 8, 1913.

Advancement of Drainage Work in North Carolina. Address before convention of the North Carolina Drainage Association, Charlotte, N. C., November 18, 1913.

Bond Issue for Good Roads. Address at Mountain City, Tenn., December 6, 1913.

Economics of Convict Labor. Address delivered before the American Road Builders' Association, Philadelphia, December 10, 1913.

Occurrence and Utilization of Certain Minerals of the Southern States. An address before the American Association for the Advancement of Science, Atlanta, Ga., December 31, 1913.

Prison Labor. Address before section of Economics, American Association for the Advancement of Science, Atlanta, Ga., January 1, 1914.

Road Demonstration. Address delivered at Whiteville, N. C., February 7, 1914.

Sand-clay Roads. Address before Virginia Road Builders' Association, Richmond, Va., February 10, 1914.

Construction of the Sand-clay and Topsoils Roads. Lecture delivered before the School of Highway Engineering, University of Tennessee, Knoxville, Tenn., February 27, 1914.

Dirt Roads and Their Maintenance. Lecture before the School of Highway Engineering, University of Tennessee, Knoxville, Tenn., February 27, 1914.

Sand-clay, Topsoil, and Gravel Roads. Lecture before the Good Roads Institute, University of North Carolina, Chapel Hill, N. C., March 18, 1914.

Organization of Convict Labor. Address before the Road Commissioners of Georgia, Atlanta, Ga., April 5, 1914.

Drainage of Swamp Lands in North Carolina. Address before the National Drainage Congress, Savannah, Ga., April 24, 1914.

Bond Issue for County Roads. Address before mass-meeting at Roxboro, N. C., May 4, 1914.

Centralized or General Control of Our Fisheries as Opposed to Local Control. Address before the National Association of Shellfish Commissioners, Atlantic City, May 8, 1914.

A Forest Policy for North Carolina. An address before the North Carolina Forestry Association, Asheville, June 10, 1914.

Good Roads and Good Citizenship. Address at Fourth of July Celebration at Cary, N. C., July 4, 1914.

The Industrial History of North Carolina as Influenced by Her Natural Resources. A series of lectures delivered before the Summer School of the University of North Carolina, July 6-14, 1914.

1. Introductory lecture.
2. Soils; Their Erosion and Conservation.
3. Water Resources.
4. Forests of North Carolina, and Her Timber Industries.
5. Fisheries of North Carolina.
6. Mineral Resources of North Carolina.
7. Relation of Transportation to Development of Natural Resources.

North Carolina's Public Road Policy. Address before the Convention of North Carolina Good Roads Association, Durham, N. C., July 9, 1914.

Revenue for Road Construction. Address at Wilkes County mass-meeting, Wilkesboro, N. C., October 5, 1914.

Presidential Address. Address at Bristol, Va., before Annual Convention of Southern Appalachian Good Roads Association, October 6, 1914.

Intercounty Highways. Address at intercounty mass-meeting, Bryson City, N. C., October 13, 1914.

Needs of the County (Orange). Address at Rally Day Celebration, Hillsboro, Orange County, N. C., October 17, 1914.

Reclamation of Swamp Lands. Address at Bolton, Columbus County, N. C., November 6, 1914.

Educational Field of State Highway Commissions. Address at Atlanta, Ga., before American Road Congress, November 9, 1914.

Public Roads and Drainage. Address at Wilmington (N. C.) Corn Show, November 13, 1914.

Reclamation Work in North Carolina. Address at Wilson, N. C., before the North Carolina Drainage Association, November 17, 1914.

Road Construction and Revenue. Address at Newport, Tenn., mass-meeting, November 21, 1914.

FINANCIAL STATEMENT.

There is given below a statement which shows receipts and expenditures of the North Carolina Geological and Economic Survey for the two years ending November 30, 1914, grouped according to subjects investigated during this time. These are arranged separately for the two years. The *receipts* cover moneys received from the State Treasury, representing the annual appropriation, and other sums received from individuals for coöperative work of various kinds as indicated, and from other sources:

DECEMBER 1, 1912, TO NOVEMBER 30, 1913.

Receipts.

Balance on hand	$ 541.50
Annual appropriation	10,000.00
Annual appropriation for roads	5,000.00
Cash from Southern Appalachian Good Roads Association on account of stenographic work	25.00
Cash from J. H. Pratt on account of overcharge in January expense account	1.00
Cash from Southern Express Company on account of damage to electros	5.00
Cash from North Carolina Good Roads Association for stenographic work	25.00
Cash from exhibitors at National Conservation Exposition	60.00
Cash from American Forestry Association on account of clerical work	20.32
Cash for typewritten list of county commissioners	1.50

Disbursements.

General geological and mineralogical investigations	$ 1,548.34
Good roads investigations	5,029.00
Forestry investigations	2,851.17
Drainage investigations	514.90
Fish and oyster investigations	461.32

Geological Board expenses	$ 129.15	
Clerical and editorial work	3,541.29	
Other office expenses	1,602.26	
Balance on hand	1.89	
	$15,679.32	$15,679.32

DECEMBER 1, 1913, TO NOVEMBER 30, 1914.

Receipts.

Balance on hand	$ 1.89
Annual appropriation	10,000.00
Annual appropriation for roads	5,000.00
Loan on account of warrant	1,000.00
Cash from Pitt County on account of maps	150.00
Cash towards expenses of logging National Highway	38.50
Cash for transportation on reports	4.28
Cash from J. W. Martin for Abney hand level	13.50
Cash from J. H. Pratt on account of overcharge on July expense account	1.00
Cash on account of exhibits at State Fair	74.08
Cash U. S. Office of Public Roads on account of coöperative work	45.00

Disbursements.

General geological and mineralogical investigations	$ 1,634.87	
Good roads investigations	5,297.60	
Forestry investigations	2,368.01	
Drainage investigations	530.11	
Fish and oyster investigations	418.80	
Geological Board expenses	83.50	
Clerical and editorial expenses	3,472.78	
Other office expenses	1,515.80	
Loan and interest	1,005.00	
Balance on hand	1.78	
	$16,328.25	$16,328.25

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY.

BULLETINS.

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*

2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906, 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 30 cents extra.*

3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*

4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*

5. The Forests, Forest Lands and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Postage 5 cents.*

6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*

7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*

8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Postage 16 cents.*

9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*

10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*

11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Postage 8 cents. Cloth-bound copy 30 cents extra.*

13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Postage 10 cents.*

14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*

15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 6 cents.*

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents.*

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*

18. Bibliography of North Carolina Geology, Mineralogy and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy 30 cents extra.*

19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 115 pp., 8 pl. *Postage 15 cents.*

24. The Loblolly or North Carolina Pine, by W. W. Ashe, 1914. Prepared in coöperation with the Forest Service, U. S. Department of Agriculture. 8°, 190 pp., 27 pls., 4 figs. *Postage 15 cents.*

ECONOMIC PAPERS.

1. The Maple-sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Postage 4 cents.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving Localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals" describes and gives Occurrences of Chromite, Asbestos and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives descriptions of Mines worked for Gold in 1903; descriptions of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime

Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and Treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper of the Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extract from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Prof. Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Postage 3 cents.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention Held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the Two Trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads Are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina During 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina During 1911-12, by Joseph Hyde Pratt. State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 20 cents.*

Gives detailed report on Gold Mining in various counties; with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new Milling Process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarra Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report on the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a List of Gems and Gem Minerals occurring in United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems occur, as taken from United States Geological Survey Report, by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin, and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos, describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin Mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper is also given the names and addresses of Producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5 and 6, 1913. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31 and August 1, 1913, in coöperation with the North Carolina Geological and Economic Survey. Statistical Report of Highway Work in North Carolina During 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1914. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina During 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms Covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments; and Forms for Minutes of Board of Drainage Commissioners Covering the Organization of the Board up to and Including the Issue of the Drainage Bonds. Compiled by George R. Boyd, Drainage Engineer, 1914. 8°, 133 pp. *Postage 10 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the Auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and the North Carolina Geological and Economic Survey, 1914. 8°, .. pp. *Postage .. cents.*

VOLUMES.

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy 30 cents extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Postage 30 cents.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Postage 35 cents.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller, and L. W. Stephenson.
Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. Birds of North Carolina. *In press.*

BIENNIAL REPORTS.

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies of drinking-waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county-seats in North Carolina; list of Magnetic Declination at the county-seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by U. S. Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over this Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Asheboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°. 176 pp. *Postage 12 cents.*

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, post-office address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, free of charge, except that in each case applicants for the reports should forward the amount of *postage* needed, as indicated above, for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, STATE GEOLOGIST

BIENNIAL REPORT

OF THE

STATE GEOLOGIST

1915-1916

RALEIGH
EDWARDS & BROUGHTON PRINTING CO.
STATE PRINTERS
1917

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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, STATE GEOLOGIST

BIENNIAL REPORT

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LETTER OF TRANSMITTAL

Chapel Hill, N. C., January 3, 1917.

To His Excellency, Hon. Locke Craig, *Governor of North Carolina:*

Sir:—I herewith submit my Biennial Report on the operations of the North Carolina Geological and Economic Survey for the years 1915 and 1916. I have included in this report several papers giving the results of investigations upon special subjects that have not been published, and yet, it is thought, should be printed and put in permanent form for reference. A financial statement covering the expenditures of the Survey for the past two fiscal years is also made a part of this report.

Yours respectfully,

Joseph Hyde Pratt,
State Geologist.

51065

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BIENNIAL REPORT

OF THE

STATE GEOLOGIST

ON THE OPERATIONS OF THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY FOR THE TWO YEARS ENDING NOVEMBER 30, 1916

BY JOSEPH HYDE PRATT, STATE GEOLOGIST.

INTRODUCTION

The North Carolina Geological and Economic Survey is called upon to undertake, first, a very varied line of investigations relating to the occurrence, conservation, and development of the natural resources of the State; and second, to carry out such measures as may be authorized by the General Assembly for developing and utilizing these resources.

The act establishing the North Carolina Geological and Economic Survey was passed by the Legislature of 1905, and outlines in detail the phases of work to be carried out by this Department, as follows:

(1) The examination of the mineral, forest, fishery, and other resources of the State.

(2) The examination of the geological formations of the State with reference to their economic products.

(3) The examination of the road-building materials and the best methods of utilizing same.*

(4) The examination and classification of the soils and forests and other physical features of the State, with special reference to their bearing upon the occupations of the people.

(5) The examination of the streams and water-powers of the State, with special reference to their development in manufacturing enterprises

*This is supplemented by an act passed by the Legislature of 1909, which made a small appropriation of $5,000 annually to be used by the Highway Division of the North Carolina Geological and Economic Survey, as follows: "The object and purpose of this appropriation shall be to enable the North Carolina Geological Board to advise with the township and county authorities in the building and improvement of the public roads by sending to the township or county a competent road engineer who will assist them in locating their improved roads, advising them as to the best road to build and how to build it, and also give advice relating to the best kind of bridge to be built in connection with the improvement of any road. The Geological Board, through the State Geologist, may make inquiries in regard to systems of road building and management throughout the United States, and make investigations and experiments in regard to the best methods of road making and the best kind of road material, and shall disseminate such knowledge by lectures to be given in the different counties, and by preparing, publishing, and distributing bulletins and reports on the subject of road improvement, and shall also gather and tabulate information and statistics on road building in North Carolina and disseminate same throughout the State."

and the preservation of the sources of these streams through the protection of the forests.

(6) The examination of the water supplies of the State, with special reference to sinking deep artesian wells.

(7) The preparation of reports regarding these investigations.

As will be seen from the above outline, the work of this Department is varied and extensive, and touches the diverse interests of all sections of North Carolina, with their varied climatic and topographical conditions.

To carry on all the lines of work outlined as being the objects of the Geological Survey at one time, with the small annual appropriation at present allotted for this work, would be an impossibility; but the Geological Board undertakes and carries out such of these investigations as seem to be most urgent and as can be accomplished with the said appropriation, supplemented by the heartiest coöperation on the part of the various Federal bureaus, such as the United States Office of Public Roads and Rural Engineering, the United States Geological Survey, the United States Coast and Geodetic Survey, the United States Forest Service, the United States Fisheries Commission, the National Association of Audubon Societies, the American Association of State Highway Officials; and various State associations, such as the North Carolina Good Roads Association, the Southern Appalachian Good Roads Association, the North Carolina Drainage Association, the North Carolina Forestry Association and the North Carolina Fisheries Society.

The Survey not only examines into the present conditions of these various natural resources and conditions affecting the State's advancement, but, where there seems to be a crying need for the conservation and perpetuation of certain of our resources, such as our forests and the commercial fisheries, it seeks to acquire all possible information and to give such publicity as will acquaint the citizens of the State with the great necessity for conserving and perpetuating the wealth with which nature has so abundantly endowed us. No attempt is made on the part of the Survey to cloak any adverse conditions; but an effort is made to reveal the true state of affairs with the idea that by making a correct diagnosis a cure can the sooner be reached. It is believed by those familiar with the work of this Department that many of the great economic problems of the present and future are involved in its work. Every effort has been made to educate and arouse the people of the State to the importance of proper methods of conservation not only of our so-called natural resources, but of our time, labor and money in the construction of better roads. Such educational work is carried on by means of addresses, bulletins, correspondence, newspaper articles, conventions, exhibits, demonstration work, etc.

One of the greatest handicaps to the work of the Survey during the past two years has been the lack of funds for printing its reports. As outlined above, the work of the Survey consists mainly in studying conditions and making reports to the people as to the results of these investigations. To be of value to the State, these reports should be distributed at the time when they would have the most value, either in conserving the interests of the people or advertising our resources at the time when these resources are in most demand. Delay in publication may mean, and often does mean, the withholding of information which costs the State many thousands of dollars because of delayed action which may have resulted through the publication and distribution of the information compiled from a given investigation. The people of North Carolina have a right to the results of the work which they have authorized.

The legislation passed by the General Assembly of 1915, which was advocated by the Survey and represents its work, was:

State-wide Fisheries Act.
State Highway Commission Act.
Forest Fire Act.
Forest Area Purchase Act.
Arbor Day Act.

In addition to the above, a special bill was also passed relating to the purchase of the Mount Mitchell Area.

This represents the most constructive legislation passed by any one General Assembly, and the Board is to be congratulated that the measures, for which the members have stood and fought, have been enacted into law.

The State Geologist has also submitted in this report certain recommendations relating to legislation that it is believed should be passed in order to enable the State (that is, the people as a whole), to reap the greatest benefit from its natural resources, both now and in the future.

It is not possible in this report to give more than a brief outline of the work of this Department, but the members of the General Assembly are respectfully referred to the detailed reports of the investigations and work of the Survey that have been published as volumes, bulletins, economic papers, and circulars, a list of which are given at the end of this report.

The personnel of the North Carolina Geological and Economic Survey for the past two years has consisted of the following, who have been employed for either the whole or a part of their time:

Joseph Hyde Pratt, *State Geologist and Engineer.*
J. S. Holmes, *State Forester.*
Miss H. M. Berry, *Secretary and Statistician.*

Geologists—Edward W. Berry, John E. Smith.

Chemists—J. M. Bell, Frank P. Drane.

Road Engineers—D. Tucker Brown, R. P. Coble, T. F. Hickerson, R. T. Brown, W. N. Garrett, G. B. Wickham, B. L. Field, R. M. Homewood, Collier Cobb, Jr.

Lecturers on Roads—H. B. Varner, C. M. Strahan, W. W. Crosby, A. D. Williams.

Road Superintendent—H. Hocutt.

Road Assistants—Oscar D. Brooks, C. T. Gorenple.

Stenographers—Miss Lillian Matthews, Miss Elizabeth Bain, Mrs. E. S. McGehee, Miss Nan McArn, Miss Pearl Hildebrand, Miss Eliza Knox, Miss Carrie Moses, Miss Margaret Berry, Miss Myrtice Greenwood, Arthur Mayer, Mrs. M. B. Strayhorn.

Draughtsmen—C. W. Higgins, E. J. Lilly, Jr., W. S. Wicker.

Coöperators in Fire Prevention—L. L. Bishop, A. R. Bauman, J. P. Gibbs.

Office Assistants—L. H. Jobe, Arthur Utley, James Phipps, Charles Phipps, Gilbert Craig, J. K. Holloway, Ralph Williams.

The following Federal Patrolmen have been employed by the State Forester under the Weeks Law, their pay coming from the United States Forest Service.

John Riis, Tryon Area.
J. H. Metcalf, Tryon Area.
George W. Stepp, Mount Mitchell Area.
Anderson McFalls, Mount Mitchell Area.
C. D. Cannon, Linville Area.
Frank Icenhour, Linville Area.

MINERALOGICAL AND GEOLOGICAL INVESTIGATIONS

MINERALOGICAL INVESTIGATIONS

Perhaps the most important mineralogical work of the Survey is that relating to the Mining Industry of the State. Not only are statistics collected regarding the production of the various minerals, but also a study is made of the general conditions of the mining industry. New occurrences of commercial minerals are investigated, and an attempt is made to keep in touch with all those who have commercial minerals and with those who desire supplies of various minerals. In this way it is often possible to bring the producer and consumer together.

Similar arrangements were made with the United States Geological Survey as for several years past, for collecting statistics regarding the production of minerals in North Carolina during the years 1914 and 1915. By this agreement the State Survey is enabled to collect these statistics as special agent of the United States Geological Survey and has the use of the franked envelope. The United States Geological Survey furnished the franked envelopes, statistic cards, and the State Survey a special letter signed by the State Geologist, copy of which is given below, which was sent to each producer.

Dear Sir:—Arrangements have been made between the U. S. Geological Survey and the North Carolina Geological and Economic Survey by which

the collecting of the mineral statistics of North Carolina will be done coöperatively by the two Surveys. This will avoid duplication of reports. The State Geologist would request that the producer will report promptly in the enclosed franked envelope, which requires no postage, as it will very materially assist the work of the State Survey as well as the Federal Survey. These reports that are published by the State and Federal Surveys are becoming more and more in demand each year and their value is enhanced by their early publication.

All information will be held confidential, only totals by counties being published, except where permission is given by the individual operator to use his figures separately.

Trusting that you will give the request for statistics regarding the production of your mineral prompt attention, I am,

Yours very truly,

JOSEPH HYDE PRATT,
State Geologist of North Carolina.
Field Assistant, U. S. Geological Survey.

The United States Geological Survey also tabulated the reports as they came in and furnished the State Survey with such tabulations. The State Survey, where it was necessary, had personal visits made to the producers in order to obtain the desired information.

Mineral specimens are constantly being received at the Survey office for identification and analysis. While the majority of these do not represent anything of commercial or scientific value, yet occasionally one is found which does, and if there is any prospect of the mineral occurring in commercial quantity, the Survey assists in bringing the owner of the property in communication with those desiring such mineral. On the other hand, when the specimen proves to be of no commercial value, the Survey has, by notifying the sender of this, been able to save him the expense of chemical analyses and assays. The Survey makes no charge for the mineralogical determination of a mineral or rock, but if an assay or chemical analysis is desired, a special charge is made for such work.

During the past two years about 523 samples of minerals have been examined and reported upon by the Survey. A few of these have been of considerable interest, as:

Clay (good for pottery), from E. C. Leonard, Greensboro, N. C.
Manganese, from R. E. Freeman, Dobson, N. C.
Galena, from C. E. Lyman, Asheville, N. C.
Halloysite, from J. A. Baker, Summit, N. C.
Metallic Zinc, from Gus Fry, Carthage, N. C.
Clay (with Fuller's earth properties), from H. C. Smith, Burnsville, N. C.
Lazulite, from W. L. Thurber, High Point, N. C., Route No. 3.
Feldspar, from W. H. Herbert, Warne, N. C.
Magnetite, Hematite, Limonite, and Ilmenite, from H. E. Fries, Winston-Salem, N. C.

Potash Spar, from G. F. Hankins, Lexington, N. C.
Clay (very pure), from R. L. Steele, Rockingham, N. C.
Quartz Crystal, from E. J. Oxford, Lenoir, N. C.
Clay (good quality), from B. W. Jordan, Wilmington, N. C.
Allanite and Uraninite, from M. C. Grindstaff, Toecane, N. C.
Columbite, from J. A. Ruth, Marion, N. C.
Arsenopyrite, from J. A. Ruth, Marion, N. C.
Tin with Ilmenite, from Wm. Ross, Lincolnton, N. C.
Chromite, from N. C. McFalls, Cane River, N. C.
Clay (Fuller's earth variety) and Clay (smectite variety), from J. L. Phifer, Bessemer City, N. C.
Halloysite, from J. M. Randall, Worley, N. C.
Monazite, from Anson G. Betts, Asheville, N. C.
Quartz with Tourmaline, from A. V. Griffin, Big Laurel, N. C.
Fine Grained Pyrite, from E. A. Shaffer, Rosman, N. C.
Chromite, from C. Blakenship Pensacola, N. C.
Alum, from J. R. Pate, Bee Log, N. C.
Rutile and Tourmaline, from Mrs. J. M. Duncan, Hiddenite, N. C.
Drusy Quartz, from Fred Pittman, Hawk, N. C.
Native Copper, from Harry G. Petree, Rural Hall, N. C.
Manganese, from Geo. W. Jones, Bostic, N. C.
Hematite and Epidote, from W. Q. A. Graham, Statesville, N. C.
Ambergris, from C. F. Williams, Avon, N. C.
Magnetite, from N. Buckner, Asheville, N. C.
Beryl, from C. Y. Logan, Rutherfordton, N. C.
Columbite, from L. A. Gettys, Shelby, N. C.
Kaolin, from J. A. Smith, Bessemer City, N. C.

GEOLOGICAL INVESTIGATIONS

Kaolin

An examination was made of the kaolin in the vicinity of Franklin, Macon County, and some of these deposits are now being investigated commercially.

Very promising clay deposits have recently been investigated in Bessemer City, Gaston County, and the indications are that it occurs in very large quantity. The quality of the clay is reported to be very good.

The kaolin that is found with the cassiterite (tin ore) at the Piedmont tin mine near Lincolnton, Lincoln County, is of good quality but at the present time it is not being utilized. If the kaolin was saved as a by-product in mining and concentrating the tin ore, the mine would be a much more profitable producer.

Considering the quality of the clays of North Carolina, there is a splendid commercial opportunity for the establishment of a large pottery manufacturing plant in this State.

Gold and Copper

Two brief examinations were made by the State Geologist of certain gold and copper deposits: The Coggins Gold Mine, near Eldorado,

N. C.; the Union gold and copper deposits at Gold Hill, N. C.; the Ore Knob copper mine, Ashe County.

The very great advance in the price of copper has aroused a lively interest in the copper deposits of the State. Several of the copper mines, as the Union in Rowan County, the Durgy in Person County, and the Ore Knob in Ashe County, are in active operation. Negotiations are under way for the reopening of others, as the Holloway in Person County, the Blue Wing in Granville, the Cullowhee in Jackson, and the Gap mine in Watauga County.

The coöperative report on the Virgilina Copper District, prepared by the North Carolina Geological and Economic Survey in coöperation with the Virginia Geological Survey, has been completed and is now being printed.

Monazite

The European War has caused a renewed interest in the monazite and zircon deposits of North Carolina, and the State Geologist has prepared a report on minerals used in the production of chemical compounds employed in the manufacture of lighting apparatus, including zircon, gadolinite, monazite, columbite, and tantalite. In this report he has taken up a thorough discussion of the monazite and zircon deposits and the general trade in its relation to these minerals. This has been published as Bulletin 25.

Coastal Plain Geology

Work has continued on the paleontology of the Coastal Plain Region of the State, and two reports are well under way:

1. Paleontology of the Cretaceous Formation.
2. Paleontology of the Tertiary Formation.

The manuscript for the first report has been completed and has been edited by Dr. W. B. Clark, under whose direct supervision the investigations had been made. The contributors to this report are Dr. L. W. Stephenson, Dr. C. W. Gilmore, Dr. E. W. Berry, Miss M. J. Rathborn, Dr. R. S. Bassler, and Dr. T. Wayland Vaughan.

The manuscript for the report on the Paleontology of the Tertiary is now nearly completed by its several contributors, consisting of Miss Julia Gardner, Dr. O. P. Hay, Dr. Bartsch, Dr. R. S. Bassler, Dr. W. B. Clark, Dr. T. Wayland Vaughan, Miss M. J. Rathborn, and Dr. J. A. Cushman.

These two reports which have been compiled in coöperation with the United States Geological Survey will make very valuable additions to the historical geology of the State. The volume relating to the economic geology of the Coastal Plain Region has already been published as Volume III of the Survey reports.

The United States Geological Survey, in addition to the above, has prepared other reports on North Carolina geology, as follows:

A report on the occurrence of mica in the United States, describing the mica deposits of North Carolina, was completed in July, 1916, by Mr. Douglas B. Sterrett. The text and maps for the Kings Mountain and Gaffney quadrangles, the larger part of which lie in South Carolina, were practically completed by Mr. Sterrett, and the geologic folio is almost ready to be submitted for publication. The maps and text for the Lincolnton quadrangle are about completed by Mr. Sterrett, and will be published in a folio that will cover also the Gastonia quadrangle, where work will be undertaken later. The United States Geological Survey has published no folio for any part of North Carolina during the past two years.

MAPPING OF THE STATE

There was no topographic mapping of any portion of the State during the past two years, due largely to the fact that the State has not made any appropriation to enable the State Survey to coöperate with the Federal Survey in this work. These topographic maps are of very great value to the State in connection with its geological, highway, drainage, forestry, and water resources work; and they are of inestimable value to many engineers engaged in various lines of engineering work throughout the State. On account of this great need for a complete topographic map of the United States, a committee has recently been appointed to take up actively the question of arousing public opinion so that a demand will be made on Congress for a sufficient appropriation to complete such a map at an early date. The committee is known as the "Committee to Expedite the Completion of the Topographic Map of the United States," and the State Geologist is one of its members. The personnel of the Committee is as follows:

W. M. Davis, Chairman, Professor of Geology, Emeritus, Harvard University, Cambridge, Mass.

A. E. Burton, Secretary, Dean, Massachusetts Institute of Technology, Cambridge, Mass.

Robert Bacon, President National Security League, New York.

Arthur H. Blanchard, Consulting Engineer National Highways Association, Professor of Highway Engineering, Columbia University, New York.

G. P. Coleman, State Commissioner of Highways, Richmond, Va.

G. E. Condra, President National Conservation Congress, State University, Lincoln, Neb.

W. L. Darling, Chief Engineer, Northern Pacific Railway Company, St. Paul, Minn.

R. E. Dodge, President, National Council Geography Teachers, Teachers College, New York.

A. B. Fletcher, State Highway Engineer, Sacramento, Cal.

W. Cameron Forbes, of J. M. Forbes & Co., Boston, Mass.
John R. Freeman, Consulting Engineer, Providence, R. I.
W. O. Hotchkiss, State Geologist, Madison, Wis.
F. H. Newell, Professor of Civil Engineering, University of Illinois, Urbana, Ill.
Joseph Hyde Pratt, State Geologist, Chapel Hill, N. C.
Wm. Barclay Parsons, Consulting Engineer, New York.
Charles A. Stone, of Stone & Webster, Boston, President International Corporation, New York.
Frank M. Williams, State Engineer, Albany, N. Y.

A certain amount of topographic mapping has been done in eastern North Carolina by the United States Coast and Geodetic Survey, and is described beyond.

MAPS FOR SCHOOL WORK, ILLUSTRATING PHYSIOGRAPHIC TYPES

The United States Geological Survey is offering to the schools of the country certain topographic maps which illustrate physiographic features which should be taught in connection with the studies of geography. The following letter, with return blank, has been sent out:

WASHINGTON.

THE PRINCIPAL, *Public High School.*

DEAR SIR:—I inclose a copy of the map of ..... which I am sure will be of interest to your scholars, as it shows not only the topography but also the roads, railways, schools, and individual houses in your immediate neighborhood.

I inclose also a circular explaining the special features of the Survey maps and a list of maps that are useful in the study of physical geography. With the exceptions noted on the circulars, the price of these maps is 10 cents retail or 6 cents each for 50 or more. I shall be glad, however, to let your school have 25 or more, in any assortment, at 6 cents each. I make this special offer because the Survey is desirous that every one shall learn the use and value of its maps, and the schoolroom seems the ideal place to start.

In addition I send you a copy of the 1-cent map of the United States, which might be useful in some of your classes. If ordered with at least 25 of the other maps, as suggested above, these United States maps will be furnished at the rate of five for 3 cents. The prices of larger United States maps are stated on the circular.

Yours very truly,
GUY E. MITCHELL,
Acting Chief Clerk.

(Inclosures.)

Name.....
Address.....
Date.....

THE DIRECTOR, *U. S. Geological Survey,*
Washington, D. C.

In reply to your letter of ....., extending a special offer to schools, I inclose $....., for which please send me United States maps

North Carolina State Library
Raleigh

as follows: ..... copies 49 by 76 in., ... copies 18 by 28 in., ... copies 11 by 16 in., ... copies 8½ by 12 in.; also one copy each of those indicated below so far as my remittance will cover their cost. (Note that the wholesale rate on the small United States map is five copies for 3 cents.)

MOUNTAINS AND OTHER FEATURES OF STRONG RELIEF

Isolated high mountain peak.....Mount Rainier National Park, Wash.
Plateau.....Hollow Springs, Tenn.
Parallel ridges .....Harrisburg, Pa.

PLAINS

Bolson plain or desert valley.....Carson Sink, Nev.

RIVERS

Waterfall.....Niagara, N. Y.
River delta.....Berners Bay special, Alaska.
Natural levee and oxbow cut-off.....Bayou Sara, La.

VALLEY FORMS

Canyon.....Canyon, Wyo. (Yellowstone National Park).
Newly established drainage system.....Tallula, Ill.
Mature drainage system.....Milledgeville, Ga.
Badland .....Ray, North Dakota.
Incised stream meander.....Lockport, Ky.
Abandoned river valley.....Sciotoville, Ohio.
Silt-drowned valley.....Madisonville, Ky.

SHORE FEATURES

Bold, rugged coast.....Tamalpais, Cal.
Beaches and spits.....San Diego, Cal.
Partly submerged coast.....Penobscot Bay, Maine.
Ocean terrace.....Oceanside, Cal.

GLACIAL FEATURES

Glacier and glacial cirque....Chief Mountain, Mont. (Glacier National Park).
Glacier moraine.....Oconomowoc, Wis.
Drumlin .....Weedsport, N. Y.

MISCELLANEOUS LAND FORMS

Sink hole.....Princeton, Ky.
Sand dune.....Moses Lake, Wash.
Hypsometric map of the United States.

ENGINEERING FEATURES

Reclamation project (reservoir).....Roosevelt, Ariz

(If more room is needed use the reverse side of this blank.)

The features illustrated on the North Carolina maps are as follows:

Barrier Beaches:
Norfolk, Va.-North Carolina.
Spits:
Norfolk, Va.-North Carolina.
Mountains not glaciated:
Cowee, N. C.-South Carolina.
Dahlonega, Ga.-North Carolina.
Mount Mitchell, N. C.-Tennessee.

Coastal Plains:
Chocowinity, N. C.
Norfolk, Va.-North Carolina.
Parmele, N. C.
Ground Valleys:
Hertford, N. C.
Early Maturity in Topography:
Coharie, N. C.
Maturity in Topography:
Mount Mitchell, N. C.-Tennessee.
Monadnocks:
Kings Mountain, N. C.-South Carolina.
Youthful Topography:
Parmele, N. C.
Sand Dunes:
Norfolk, Va.-North Carolina.
Swamps:
Beckford, N. C.
Norfolk, Va.-North Carolina.
Winton, N. C.

SOIL SURVEY MAPS

During the past two years, soil survey maps have been completed of the following areas:

Alleghany County, Anson County, Columbus County, Davidson County, Wayne County, Halifax County, Harnett County, Hertford County, and Stanly County.

The areas that are now in progress are Cleveland and Orange counties.

The following soil survey maps have thus far been made in North Carolina:

List of Soil Survey Maps

Year	Area
1901	Alamance County.
1916	Alleghany County. (In press.)
1916	Anson County. (In press.)
1912	Ashe County.
1903	Asheville area (parts of Buncombe, Madison, and Haywood counties).
1910	Cabarrus County.
1901	Cary area (part of Wake County). (Exhausted.)
1908	Caswell County.
1906	Chowan County.
1916	Cleveland County. (In progress.)
1916	Columbus County. (In press.)
1903	Craven area (parts of Pitt, Craven, and Jones counties).
1916	Davidson County. (In press.)
1905	Duplin County.
1907	Edgecombe County.

1913 Forsyth County.
1909 Gaston County.
1910 Granville County.
1904 Greenville area, Tennessee (part of Madison County, N. C.)
1916 Halifax County. (In press.)
1916 Harnett County. (In press.)
1907 Henderson County.
1916 Hertford County. (In press.)
1902 Hickory area (parts of Catawba, Lincoln, Burke, Caldwell, Alexander, and Iredell counties). (Exhausted.)
1911 Johnston County.
1909 Lake Mattamuskeet area (part of Hyde County).
1909 Mecklenburg County.
1902 Mount Mitchell area (parts of Yancey, Mitchell, Madison, Buncombe, and McDowell counties). (Exhausted.)
1906 New Hanover County. (Exhausted.)
1916 Orange County. (In progress.)
1905 Pasquotank and Perquimans counties. (Exhausted.)
1912 Pender County.
1909 Pitt County.
1900 Raleigh to New Bern (parts of Craven, Jones, Wake, Johnston, Wayne, Greene, and Lenoir counties). (Map exhausted.)
1911 Randolph County.
1911 Richmond County.
1908 Robeson County.
1914 Rowan County.
1909 Scotland County.
1916 Stanly County. (In press.)
1901 Statesville area (parts of Iredell, Mecklenburg, Lincoln, Catawba, and Rowan counties).
1906 Transylvania County.
1914 Wake County.
1915 Wayne County.

FORESTRY

In the State Geologist's Biennial Report for 1913-14, an outline was given for a Forest Policy for North Carolina, as follows:

FOREST POLICY FOR NORTH CAROLINA

a. A State forest fire protective system.

b. State-owned and operated demonstration forests and experiment stations.

c. The encouragement of forest planting by the maintenance of one or more forest nurseries.

d. The modification of taxes on nonrevenue-producing forest land.

Favorable consideration was given to many of these suggestions by the General Assembly of 1915, and several very important laws relating to the protection and conservation of our forests were passed by that body, the most important of which was the Forest Fire Law. This bill had

been advocated by the Survey for several years, and with the exception of the appropriation, the bill passed is practically the same as recommended by the Survey. While some good results have been accomplished in regard to the protection of our forests from fire, yet the need is very great for the extension of this work; but this cannot be done unless the General Assembly makes an appropriation for this purpose. This should be at least $10,000 annually.

The Forest Area Purchase Bill recommended by the Survey was also passed by the General Assembly of 1915.

There is given below a brief review of the legislation passed relating to forestry:

I. The Forestry or Forest Fire Bill, was passed during the last days of the session, but was amended so as to cut out the appropriation of $20,000. This bill provides that the State Geological Board shall have control of fire prevention and fire protective measures. The Forester of the Survey, who is to be known as State Forester, may appoint forest wardens in any county, township, or district in which the risks from fire may justify it. It provides for the payment of these wardens for the time actually engaged in their duties, which are defined. The bill also amends and strengthens the present laws against setting fire to woods and leaving camp fires unextinguished. The law can be made effective only in so far as the Survey can enforce it with the financial means at its disposal. The amendment to the present law and certain other minor features were put into force at once. The passage of this act makes it possible for the State to obtain the coöperation of the United States Forest Service under the Weeks Law.

II. The bill known as the Forest Area Purchase Act, which was prepared by the Survey, empowers the Governor to receive gifts of land for State forest purposes, and provides for the purchase of lands for State forests by the Geological Board, when any special appropriation or other funds may be available. It provides that all lands so acquired are to be held, protected and administered by the Geological Board as State forests. It is believed that the administration of the Mount Mitchell Forest Area, whose purchase was authorized by the General Assembly, would, according to this act, come under the jurisdiction of the Geological Board.

III. The passage of the Arbor Day Bill was finally accomplished, with very little opposition, and it is believed that the holding of Arbor Day celebrations in the schools throughout the State will be very beneficial in creating a sentiment for tree preservation.

IV. Another bill which was recommended by the Survey, relating to the protection of fish and game in the forest reservations of Western North Carolina, which have been purchased by the Federal Govern-

ment, was also passed. This act gives the Federal Government full power to protect all animal life within the confines of the areas which it has purchased. This is a definite step in the direction of the conservation of our animal life.

V. The Survey has been advocating the purchasing of watersheds to improve and control the water supply of towns and has given considerable advice, suggestions and recommendations regarding the purchase of such watersheds and their protection. At the last General Assembly laws were enacted to allow several towns to issue bonds to purchase or enlarge their watersheds, including Hendersonville, Tryon, Waynesville, Asheville, and Old Fort.

[Chapter 243, Public Laws of 1915.]

1. THE FOREST FIRE LAW

AN ACT TO PROTECT THE FORESTS OF THE STATE FROM FIRE

The General Assembly of North Carolina do enact:

SECTION 1. That the State Geological Board may take such action as it may deem necessary to provide for the prevention and control of forest fires in any and all parts of this State, and it is hereby authorized to enter into an agreement with the Secretary of Agriculture of the United States for the protection of the forested watersheds of streams in this State.

SEC. 2. That the forester of the State Geological and Economic Survey who shall be called State Forester, and shall be *ex officio* State Forest Warden, may appoint, with the approval of the Geological Board, one township forest warden and one or more district forest wardens in each township of the State in which the amount of forest land and the risks from forest fires shall, in his judgment, make it advisable and necessary.

SEC. 3. The State Forester, as State Forest Warden, shall have supervision of township and district forest wardens, shall instruct them in their duties, issue such regulations and instructions to the township and district forest wardens as he may deem necessary for the purposes of this act, and cause violations of the laws regarding forest fires to be prosecuted..

SEC. 4. Forest wardens shall have charge of measures for controlling forest fires; shall make arrests for violation of forest laws; shall post along highways and in other conspicuous places copies of the forest fire laws and warnings against fires, which shall be supplied by the State Forester; shall patrol during dry and dangerous seasons under the direction of the State Forester, and shall perform such other acts and duties as shall be considered necessary by the State Forester for the protection of the forests from fire. The township forest warden of the township in which a fire occurs shall within ten days make such a report thereof to the State Forester as may be prescribed by him. Each district forest warden shall promptly report to township wardens any fire in his district.

SEC. 5. Any person who shall maliciously or willfully destroy, deface, remove, or disfigure any sign, poster, or warning notice, posted by order of the State Forester, under the provisions of this act or any other act which may

be passed for the purpose of protecting the forests in this State from fire, shall be guilty of a misdemeanor and upon conviction shall be punishable by a fine of not less than ten dollars nor more than fifty dollars, or imprisoned not exceeding thirty days.

SEC. 6. Forest wardens shall prevent and extinguish forest fires in their respective townships and enforce all statutes of this State now in force or that hereafter may be enacted for the protection of forests and woodlands from fire, and they shall have control and direction of all persons and apparatus while engaged in extinguishing forest fires. Any forest warden may arrest, without a warrant, any person or persons taken by him in the act of violating any of the said laws for the protection of forests and woodlands, and bring such person or persons forthwith before a justice of the peace or other officer having jurisdiction, who shall proceed without delay to hear, try, and determine the matter. During a season of drought the State Forester may establish a fire patrol in any township, and in case of fire in or threatening any forest or woodland the township or district forest warden shall attend forthwith and use all necessary means to confine and extinguish such fire. The said forest warden may summon any male resident of the township between the ages of eighteen and forty-five years to assist in extinguishing fires, and may require the use of horses and other property needed for such purpose; any person so summoned, and who is physically able, who refuses or neglects to assist or to allow the use of horses, wagons, or other material required, shall be liable to a penalty of not less than five dollars nor more than fifty dollars. No action for trespass shall lie against any forest warden or person summoned by him for crossing or working upon lands of another in connection with his duties as forest warden.

SEC. 7. Forest wardens shall receive compensation from the Geological Board at a rate of not to exceed twenty cents per hour for the time actually engaged in the performance of their duties; and reasonable expenses for equipment, transportation, or food supplies incurred in fighting or extinguishing any fire, according to an itemized statement to be rendered the State Forester every month, and approved by him. Forest wardens shall render to the State Forester a statement of the services rendered by the men employed by them or their district wardens, as provided in this act, within one month of the date of service, which said bill shall show in detail the amount and character of the service performed, the exact duration thereof, the name of each person employed, and any other information required by the State Forester. All accounts of the forest wardens must be duly sworn to before a justice of the peace, notary public, or other officer qualified to witness such papers within the county in which the expenses were incurred. If said bill be duly approved by the State Forester, it shall be paid by direction of the Geological Board out of the funds hereinafter provided for.

SEC. 8. If any person shall intentionally set fire to any grass land, brush land, or woodland, except it be his own property, or in that case without first giving notice to all persons owning or in charge of lands adjoining the land intended to be fired, and also taking care to watch such fire while burning and taking effectual care to extinguish such fire before it shall reach any lands near to or adjoining the lands so fired, he shall for every such offense be guilty of a misdemeanor and shall be fined not less than ten dollars nor more than fifty, or imprisoned not exceeding thirty days. This shall not prevent action for damages sustained by the owner of any property from such fires.

Sec. 9. Any wagoner, hunter, camper, or other person who shall kindle a camp fire or shall authorize another to kindle such fire, unless all combustible material for the space of ten feet surrounding the place where said fire is kindled has been removed, or shall leave a camp fire without fully extinguishing it, or who shall accidentally or negligently, by the use of any torch, gun, match, or other instrumentality, or in any manner whatever, start any fire upon any grass land, brush land, or woodland without fully extinguishing the same, shall be guilty of a misdemeanor, and upon conviction shall be punished by a fine of not less than ten dollars nor more than fifty dollars, or imprisoned not exceeding thirty days.

Sec. 10. All persons, firms, or corporations who shall burn any tar kiln, or pit of charcoal, or set fire to or burn any brush, grass, or other material, whereby any property may be endangered or destroyed shall keep and maintain a careful and competent watchman in charge of said kiln, pit, brush, or other material while burning. Any person, firm, or corporation violating the provisions of this section shall be punishable by a fine of not less than ten dollars nor more than fifty dollars, or imprisoned not exceeding thirty days. Fire escaping from such kiln, pit, brush, or other material while burning shall be *prima facie* evidence of neglect of these provisions.

Sec. 11. For the purposes of this act, woodland is taken to include all forest areas, both timber and cutover land, and all second growth stands on areas that have at one time been cultivated.

Sec. 12. All laws and clauses of laws in conflict with this act are hereby repealed.

Sec. 13. This act shall be in force from and after its ratification.

In the General Assembly read three times and ratified this the 9th day of March, 1915.

[Chapter 56, Public Laws of 1913.]

2. PROTECTION OF CITY WATERSHEDS FROM FIRE

An Act to Protect Watersheds Owned by Cities and Towns from Damage by Fire

The General Assembly of North Carolina do enact:

Section 1. That any person, firm, or corporation owning lands or the standing timber on lands within four hundred feet of any watershed held or owned by any city or town, for the purpose of furnishing a city or town water supply, upon cutting or removing the timber, or permitting same cut or removed, from lands so within said four hundred feet of said watershed, or any part thereof, shall, within three months after cutting, or earlier upon written notice by said city or town, remove or cause to be burned under proper supervision, all treetops, boughs, laps, and other portions of timber not desired to be taken for commercial or other purposes, within four hundred feet of the boundary line of such part of said watershed as is held or owned by such town or city, so as to leave such space of four hundred feet immediately adjoining the boundary lines of such watershed so held or owned free and clear of all such treetops, laps, boughs, and other inflammable material caused by or left from cutting such standing timber, so as to prevent the spread of fire from such cutover area and the consequent damage to such watershed.

Sec. 2. That any such person, firm, or corporation violating the provisions of this act shall be guilty of a misdemeanor.

Sec. 3. That this act shall be in force from and after its ratification.

In the General Assembly read three times and ratified this the 6th day of March, 1913.

[Chapter 253, Public Laws of 1915.]

3. STATE EXPERIMENT AND DEMONSTRATION FORESTS

AN ACT TO ALLOW THE ACQUIREMENT BY THE STATE OF STATE FORESTS

The General Assembly of North Carolina do enact:

SECTION 1. That the Governor of the State is authorized, upon recommendation of the Geological Board, to accept gifts of land to the State, the same to be held, protected and administered by said board as State forests, and to be used so as to demonstrate the practical utility of timber culture and water conservation, and as refuges for game. Such gifts must be absolute except in such cases as where the mineral interest on the land has previously been sold. The State Geological Board shall have the power to purchase lands in the name of the State, suitable chiefly for the production of timber, as State forests, for experimental, demonstration, educational, park, and protection purposes, using for such purposes any special appropriations or funds available. The Attorney-General of the State is directed to see that all deeds to the State of land mentioned in this section are properly executed before the gift is accepted or payment of the purchase money is made. Said State forests shall be subject to county taxes, assessed on the same basis as are private lands, to be paid out of moneys in the State Treasury not otherwise appropriated.

SEC. 2. That all moneys received from the sale of wood, timber, minerals, or other products from the State forests shall be paid into the State Treasury and to the credit of the Geological Board; and such moneys shall be expended carrying out the purposes of this act and of forestry in general, under the direction of the Geological Board.

SEC. 2½. That nothing in this act shall operate or be construed as authority for the payment of any money out of the State Treasury for the purchase of lands or for other purposes unless by appropriation for said purpose by the General Assembly.

SEC. 3. That all laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 4. That this act shall be in force from and after its ratification.

In the General Assembly read three times and ratified this the 9th day of March, 1915.

[Chapter 76, Public Laws of 1915.]

4. MOUNT MITCHELL STATE PARK

AN ACT TO APPOINT A COMMISSION TO ACQUIRE A PORTION OF MOUNT MITCHELL, INCLUDING THE SUMMIT, AND TO PROVIDE FOR THE CREATION OF A PUBLIC PARK FOR THE USE OF THE PEOPLE OF THE STATE OF NORTH CAROLINA

WHEREAS the summit of Mount Mitchell in Yancey County is the greatest altitude east of the Rocky Mountains, and whereas the headwaters of many of the important streams of the State are at or near the said summit, and the forest is being cleared, which tends to damage and injure the streams flowing through the said State from the mountains to the Atlantic Ocean; and whereas it is deemed desirable that this beautiful and elevated spot shall be acquired and permanently dedicated as a State park for the use of the people of the entire State seeking health and recreation; and whereas, unless the

said land is acquired by the State at this time, the cost of acquiring it at a later date will be greatly increased and the watercourses may be damaged, and the beauty of the scenery destroyed by removing the growth therefrom; and irreparable damage accrue; now, therefore,

The General Assembly of North Carolina do enact:

SECTION 1. That a commission is hereby created to consist of five practical business men who shall be appointed by the Governor and which shall carry out the provisions of this act, and shall be known as the "Mitchell Peak Park Commission."

SEC. 2. That said commission shall be and is hereby created a body politic and corporate, under the name and style of the "Mitchell Peak Park Commission."

SEC. 3. That the said commission shall have the power to fix the time and place of its meeting. Said commissioners shall hold office until the property hereinafter described shall have been purchased and a deed made to the State of North Carolina, and until they shall have made a report of the same to the General Assembly and shall have been discharged. In the event of the death or resignation of any member of said commission, his successor shall be appointed by the Governor. The said commissioners shall receive no compensation but their traveling expenses, including hotel bills, while actively engaged in the work of said commission, and these expenses shall be paid out of the funds hereinafter provided for: *Provided*, that the said commission shall under no circumstances expend or contract to expend a greater amount than that named in this act for the purchase of said land.

SEC. 4. The said commission shall convene as soon as practicable and elect a chairman. The said chairman shall from time to time draw a warrant or warrants upon the treasurer of the State, which, after being approved and countersigned by the Governor and two other members of the commission besides the chairman, shall be paid by the said treasurer to the owner of said lands purchased for the said purpose out of any funds not otherwise appropriated.

SEC. 5. The total amount to be expended under this act shall not exceed twenty thousand dollars, and the said sum of twenty thousand dollars is hereby designated as a maximum amount to be expended in the acquisition of the said properties, and the said commission is especially charged with the duty of acquiring as much of the lands as is possible for the purpose intended, not exceeding the maximum amount hereinbefore designated.

SEC. 6. Out of the funds so appropriated the said Mitchell Peak Park Commission shall have power as soon as practicable to acquire, either by purchase or condemnation, so much of Mount Mitchell, including the peak thereof, as they shall deem necessary as a suitable site for the purpose intended, and in the event of the purchase of said land or lands privately from the owner or owners thereof, the said commission shall take a deed to the State of North Carolina therefor.

SEC. 7. Whenever from any cause the said commission cannot agree with the owner or owners of the land which they shall select for the purpose of the park, as aforesaid, as to the price to be paid for the same or for any part thereof, said land or lands may be taken at a valuation to be made by three competent and disinterested freeholders of the county of Yancey, one of whom, after due notice to the landowner of such proceedings, shall be chosen

by the said commission, one selected by the landowner, and these two shall select a third; and in case the landowner refuses to select, then said commission shall select two, and these two shall select a third, and said freeholders, after being duly sworn by a justice of the peace of the county of Yancey, shall at once go on said land and proceed to condemn said land or lands and ascertain the sum which shall be paid the owner or owners of said properties, and report the same to the said commission, under their hands and seals; which report, on being confirmed by the said commission and spread upon their minutes, shall have the effect of a judgment against the said Mitchell Peak Park Commission, and upon paying said sum to the landowner or, in the event of an appeal, upon paying said sum to the chairman of said commission to await the result of such appeal, shall pass title to the State of North Carolina of the land so taken: *Provided*, that if any person whose land is taken for the said purpose or the said commission be dissatisfied with the valuation thus made, then and in that case either party may appeal to the next term of the Superior Court of Yancey County within ten days from the filing of such report: *Provided further*, that such appeal shall not hinder the commission from taking possession of said property.

Sec. 8. The Governor shall have power, upon complaint or upon his own motion, to remove any of said commissioners for negligence of duty or for any conduct unbecoming said commission and inconsistent with his duties under this act. The position of commissioner under this act shall not be construed to be an office within the meaning of section seven, article fourteen of the Constitution of North Carolina. The said Mitchell Peak Park Commission shall make report to the Governor, setting forth all purchases, condemnations, and expenditures of every kind under this act.

Sec. 9. This act shall be in force from and after its ratification.

In the General Assembly read three times and ratified this the 3d day of March, 1915.

[Chapter 118, Section 5430, Revisal of 1905.]

5. APPALACHIAN NATIONAL FORESTS

United States Lands

5430. *Forest Reserve, Western Carolina.* The United States is authorized to acquire by purchase, or by condemnation with adequate compensation, except as hereinafter provided, such lands in Western North Carolina as in the opinion of the Federal Government may be needed for the establishment of a national forest reserve in that region. This consent is given upon condition that the State of North Carolina shall retain a concurrent jurisdiction with the United States in and over such lands so far that civil process in all cases, and such criminal process as may issue under the authority of the State of North Carolina against any person charged with the commission of any crime without or within said jurisdiction, may be executed thereon in like manner as if this consent had not been given. Power is hereby conferred upon the Congress of the United States to pass such laws as it may deem necessary to the acquisition, as hereinbefore provided; for incorporation in such national forest reserve such forest-covered lands lying in Western North Carolina as in the opinion of the Federal Government may be needed for this purpose, but as much as two hundred acres of any tract of land occupied as a home by *bona fide* residents in this State on the eighteenth

day of January, one thousand nine hundred and one, shall be exempt from the provisions of this section. Power is hereby conferred upon Congress to pass such laws and to make or provide for the making of such rules and regulations, of both civil and criminal nature, and to provide punishment therefor, as in its judgment may be necessary for the management, control, and protection of such lands as may be from time to time acquired by the United States under the provisions of this section.

[Chapter 205, Public Laws of 1915.]

6. PROTECTION OF GAME ON NATIONAL FORESTS

AN ACT TO GIVE THE CONSENT OF THE STATE OF NORTH CAROLINA TO THE MAKING BY THE CONGRESS OF THE UNITED STATES, OR UNDER ITS AUTHORITY, OF ALL SUCH RULES AND REGULATIONS AS IN THE OPINION OF THE FEDERAL GOVERNMENT MAY BE NEEDFUL IN RESPECT TO GAME ANIMALS, GAME AND NON-GAME BIRDS, AND FISH ON LANDS, AND IN OR ON THE WATERS THEREON, ACQUIRED OR TO BE ACQUIRED BY THE FEDERAL GOVERNMENT IN THE WESTERN PART OF NORTH CAROLINA FOR THE CONSERVATION OF THE NAVIGABILITY OF NAVIGABLE RIVERS

WHEREAS, the Government of the United States, with the consent of the General Assembly of the State of North Carolina, has acquired and will acquire areas of forested land in the western part of said State for the purpose of conserving the navigability of navigable streams, and said lands and waters thereon are and will be stocked, naturally and artificially, with game animals, game and non-game birds, and fish; and

WHEREAS, in order adequately to enjoy and protect the occupancy and use of said areas, it is important that the United States be fully authorized to make all needful rules and regulations in respect to such animals, birds, and fish; therefore

The General Assembly of North Carolina do enact:

SECTION 1. That the consent of the General Assembly of North Carolina be, and hereby is, given to the making by the Congress of the United States, or under its authority, of all such rules and regulations as the Federal Government shall determine to be needful in respect to game animals, game and non-game birds, and fish on such lands in the western part of North Carolina as shall have been, or may hereafter be, purchased by the United States under the terms of the Act of Congress of March first, one thousand nine hundred and eleven, entitled "An act to enable any State to coöperate with any other State or States, or with the United States, for the protection of the watersheds of navigable streams, and to appoint a commission for the acquisition of lands for the purposes of conserving the navigability of navigable rivers" (Thirty-sixth United States Statutes at Large, page nine hundred and sixty-one), and acts of Congress supplementary thereto and amendatory thereof, and in or on the waters thereon.

In the General Assembly read three times and ratified this the 9th day of March, 1915.

[Chapter 51, Public Laws of 1915.]

7. ARBOR DAY OBSERVANCE

AN ACT TO APPOINT AN ARBOR DAY FOR NORTH CAROLINA

The General Assembly of North Carolina do enact:

SECTION 1. That the Friday following the first day of November in each year shall be known as Arbor Day, to be appropriately observed by the public schools of the State.

SEC. 2. That the Governor is herewith authorized to make proclamation setting forth the provisions of this act and recommending that Arbor Day be appropriately observed by the school children of the State, in order that they may be brought up to appreciate the true value of trees and forests to their State.

SEC. 3. That it shall be the duty of the State Superintendent of Public Instruction to take the matter of the observance of Arbor Day by the public schools of the State, under his general supervision, to issue each year a program for its observance to cover such part of the day as he may prescribe, and to transmit suitable instructions to the county school authorities under his charge for an appropriate observance of Arbor Day.

SEC. 4. That this act shall be in force from and after its ratification.

In the General Assembly read three times and ratified this the 25th day of February, 1915.

Immediately on the passage of the Forest Fire Bill, the State Geologist took up with the Forester of the United States Forest Service the question of coöperation under the Weeks Law. As a result of this correspondence, a conference was held in Washington at the office of the Forester on May twenty-eighth. After going over the situation very carefully, an agreement was drawn up by which North Carolina received $2,000 for the next fiscal year for coöperative work in protection of its forests from fires. The agreement provides that the Forest Service will permit the appointment of patrolmen and lookout men in certain areas in North Carolina to be hereafter agreed upon, the total cost to the government not to exceed $2,000 per annum. A large proportion of the salary and office and field expenses of the Forester will be counted as the State's part of the coöperative fund, because of the large amount of time given by him to work started directly or indirectly in connection with the suppression of forest fires. Copy of the agreement is as follows:

UNITED STATES DEPARTMENT OF AGRICULTURE

AGREEMENT FOR THE PROTECTION FROM FIRE OF THE FORESTED WATERSHEDS OF NAVIGABLE STREAMS

Under Section 2, Act of March 1, 1911 (36 Stat., 691)

This agreement, made by and between the Secretary of Agriculture of the United States, under authority of section 2 of the Act of Congress approved

March 1, 1911 (36 Stat., 691), and the State of North Carolina, by and through its Geological Board, witnesseth:

That whereas, the said State has requested the coöperation of the said Secretary in the protection from fire of the forested watersheds of navigable streams, and whereas the said State has provided by law for a system of forest fire protection; now, therefore, the said parties do mutually promise and agree with each other as follows:

1. To establish and maintain a coöperative fire protective system covering any or all private or State forest lands within the State of North Carolina and situated upon the watersheds of navigable rivers, and to furnish for this purpose Federal and State patrolmen or to take such other protective measures as may be deemed advisable, under the conditions hereinafter provided.

2. The said Board shall furnish maps showing the watersheds and areas which are proposed to be protected under this agreement. The coöperation shall be limited to such watersheds and areas in so far as they shall be approved by the Secretary. The said Board shall indicate the periods during which protection from forest fires is proposed under this agreement; the number of patrolmen, with their stations, which will be employed by the State; the character and extent of other protective measures which it is proposed to put into effect at the expense of the State; and the localities in which it is desired to place Federal patrolmen furnished by the Forest Service.

3. The State Forester of North Carolina, acting as an employee of the Geological Board, shall be appointed Collaborator in the Forest Service of the United States Department of Agriculture at the salary of one dollar ($1) a month, and acting in such capacity shall have direct charge of the force of Federal patrolmen employed under this agreement. The State Forester shall select the Federal patrolmen, subject to approval by the Secretary, instruct them *in writing* as to their duties, supervise their work, and certify to their services on pay rolls of the Forest Service.

4. The Federal patrolmen so selected shall be appointed as temporary laborers in the Forest Service at either a *monthly* rate not exceeding seventy-five dollars ($75) or a *per diem* rate not exceeding three dollars ($3): *Provided*, that they shall be employed exclusively in the protection of areas on the watersheds of navigable rivers which shall have been approved by the said Secretary.

5. The State Forester shall secure for the Federal patrolmen furnished under this agreement, by appointment as Deputy State Fire Wardens or otherwise, without additional compensation, such police powers for the prevention and control of forest fires as may be granted under the laws of the State of North Carolina, and shall equip such Federal patrolmen with such fire-fighting tools or devices and shall authorize them to employ such assistance in fighting fires as its funds and the State fire laws and regulations will permit.

6. The State Geologist shall, on or before January 1 of each year, submit to the Forester of the United States Department of Agriculture a budget showing the estimates of all State (excluding town and county) funds which will be available for expenditure by the State for fire protection purposes during the current calendar year, both within the coöperative area covered by this agreement and outside of said area; and based upon said budget the

said Forester shall fix the sum to be similarly expended by the Federal Government, which sum may be increased or decreased, depending on the forest fire hazard: *Provided, however*, that no Federal moneys shall be expended until the said State funds available for the hire of lookout watchmen or patrolmen have been expended for the purposes of protection for which appropriated; and *Provided further*, that in no case shall the amount expended by the Federal Government in any Federal fiscal year exceed the amount appropriated by the said State for and expended by it during the same period for the purpose of protecting from fire forested watersheds of navigable streams in said State.

7. Where the said coöperative area embraces any territory covered by a timber owners' protective association, the State Forester shall submit to the Forester a separate budget for each association, showing the estimated expenditures of all association funds which will be available for fire protection purposes during the current calendar year, both within the coöperative area and outside of said area: *Provided*, that no Federal moneys shall be expended within such territory until the funds of such association available for the hire of lookout watchmen or patrolmen have been expended for the purposes of protection for which appropriated.

8. Payment for the services of Federal patrolmen employed under this agreement shall be made at the end of each calendar or fractional month on vouchers certified by the State Forester as Collaborator, and forwarded to the Forester, Forest Service, Washington, D. C.: *Provided*, that no patrolman will be employed except during the real danger season from forest fires on the watersheds and areas approved by the Secretary under this agreement.

9. The said Secretary and his authorized representative shall have full authority to inspect the protective areas and the force herein authorized, and at his option, by giving the Geological Board written notice, may withdraw his approval of any such area or portion thereof, or terminate the employment of any Federal patrolman or patrolmen or of the State Forester as Collaborator in the Forest Service.

10. The State Forester shall be responsible for seeing that each patrolman keeps a vigilant lookout for forest fires in or threatening his district, and that he makes every possible effort to extinguish such fires as occur, whether they are on lands belonging to the State, the Federal Government, or a private owner: *Provided*, that during the patrol period when in the judgment of the State Forester patrol is unnecessary, the patrolmen may be used on other fire protection work. The State Forester or his representative shall from time to time make such personal inspection of the coöperative fire protection work done under this agreement as may be necessary to promote the effectiveness of said work.

11. The said State Forester shall, with respect to all private forest land afforded protection against fire under this agreement, use every proper means to bring about the active coöperation of the owner in such protection, including aid from him in the form of hire of one or more patrolmen, construction of permanent improvements, and the like.

12. Both the said Board and the Forest Service of the United States Department of Agriculture shall have equal right to publish the results of the coöperation under this agreement: *Provided*, that any results intended for

publication, except press notices of momentary or local interest, be approved by the Board and by the Secretary. In all such publications it shall be plainly stated that the results were secured through coöperation between the Board and the Secretary.

13. This agreement shall become effective on the first day of January, 1915, and shall continue in force thereafter, subject, nevertheless, to the availability of funds appropriated by Congress by the Act of March 1, 1911, and to any amendments thereto or extension thereof, for the purposes herein mentioned, and to any amendments which may be made hereof by mutual agreement of the parties; and it is expressly understood that this agreement or any modification hereof may be terminated by either party upon thirty (30) days written notice to the other.

In witness whereof, the said Board has hereunto caused its name and seal to be affixed by its proper officers on the 2d day of June, 1915, and the said Secretary has hereunto set his hand and affixed his official seal on the date below written.

GEOLOGICAL BOARD,
By JOSEPH HYDE PRATT,
State Geologist.
J S. HOLMES,
State Forester.
CARL VROOMAN,
Acting Secretary of Agriculture.

Signed and sealed by the Secretary of Agriculture, this 9th day of June, 1915.

In spite of the lack of appropriation, the Survey has done everything it could to carry out the spirit as well as letter of the new Forest Fire Law. It has printed and distributed large placards for posting in public places, calling the attention of the people to the provisions of the State law and warning them against forest fires. The Forestry Laws, together with explanations as to their value and the manner of their enforcement, have also been published and distributed. Distinctive and appropriate badges which will be immediately recognized by the public have been secured for the township and district wardens; see Fig. 1. No large advantage, however, can be secured by the State from this law until it appropriates money for the payment of wardens.

FIG. 1. FOREST WARDEN'S BADGE

On July 7, 1915, a conference of timberland owners, railroad men, Federal and State forest officers, was held at Montreat, N. C., in the interest of the Forest Fire Act, to secure the organization of "Forest Fire Protection Districts." The State Geologist presided over this conference. As a result of this conference and of subsequent meetings and interviews, the following districts were organized:

FOREST FIRE PROTECTION DISTRICTS

Mount Mitchell Forest Protective Association

Fred A. Perley, Black Mountain, President
J. G. Stikeleather, Asheville, Vice-President
A. E. Bauman, Montreat, Secretary
J. P. Parker, Black Mountain
C. P. Kerlee, Black Mountain
} Directors

Tryon Forestry Club

W. T. Lindsay, Tryon, President
Geo. H. Warner, Tryon
W. H. Sterns, Tryon
W. B. Stone, Tryon
} Vice-Presidents
J. B. Hester, Tryon, Treasurer
Geo. B. Cobb, Tryon, Secretary

Linville Forest Protective Association

P. Maclay Brown, Crossnore, President
A. W. Wasey, Shull's Mills, Vice-President
J. P. Gibbs, Linville, Secretary-Treasurer
L. D. Ellis, Cranberry
E. G. Underdown, Blowing Rock
} Directors

The State Forester has had general supervision of the work in all these districts; has appointed the fire wardens, by and with the approval of the Geological Board; has held meetings with the members of the different Protective Associations; and has visited the districts from time to time in planning and supervising the work.

As a result of this work, very gratifying progress has been made in the work of forest protection and a foundation has been laid for more extensive and effective work in the future, when more funds are available. The Tryon Forestry Club, through the interest of its members, has worked up a voluntary system of fire wardens for Tryon Township; while the untiring efforts of the Federal patrolmen who have been actively engaged for the past three fire seasons have succeeded in preventing any considerable fire damage, though in previous years this was one of the worst townships in the State for fires. The Mount Mitchell For-

est Protective Association, which was planned to represent the ownership of some 60,000 acres in the region of Mount Mitchell, failed to secure the support which it expected. Through the work of the Federal patrolmen, however, and the activity of some few of its members, much has been done in fire protection. It has also been clearly demonstrated that without the active support of all parties concerned, the best results can not be obtained. The Linville Forest Protective Association was organized in the spring of 1916, and it has already been shown that with the unanimous support of all the landowners in the region, a great deal can be done to prevent fires. Some 60,000 acres of land are represented by this association and all members have paid their dues, which, unlike many other such associations, are based not only upon land ownership but upon railroad mileage operated in the district. By the addition of this item, the costs of fire protection are more equitably distributed amongst members, because the fire risks are taken into consideration.

The effectiveness of all three of these organizations has suffered very materially through lack of sufficient technical supervision. It is felt that expert inspection and advice given during the fire seasons would greatly increase the efficiency of the work which is undertaken by these associations. This, together with the coöperation of State-paid forest wardens, made available by an adequate State appropriation for the administration of the present law, would double the effectiveness of such coöperative fire protection.

In March, 1916, another agreement was entered into with the United States Department of Agriculture for the fiscal year ending June 30, 1917. A copy of this agreement is given below:

UNITED STATES DEPARTMENT OF AGRICULTURE

AGREEMENT FOR THE PROTECTION FROM FIRE OF THE FORESTED WATERSHEDS OF NAVIGABLE STREAMS

Under Section 2, Act of March 1, 1911 (36 Stat., 691)

This agreement, made under authority of section 2 of the Act of Congress approved March 1, 1911 (36 Stat., 691), this 1st day of January, 1916, by and between the State of North Carolina, by and through the Geological Board (hereinafter called the "Board"), of the first part, and the Secretary of Agriculture of the United States (hereinafter called the "Secretary"), of the second part, witnesseth:

Whereas the said State has requested the coöperation of the said Secretary in the protection from fire of the forested watersheds of navigable streams, and whereas the said State has provided by law for a system of forest-fire protection, now, therefore, the said parties do mutually promise and agree with each other to establish and maintain a coöperative fire protective system, covering any or all private or State forest lands situated on the watersheds

of navigable rivers within the State, and to furnish for this purpose lookout watchmen or patrolmen and take such other protective measures as may be deemed advisable under the conditions hereinafter provided, to wit:

ARTICLE I. The Board (the State Forester acting as its agent) agrees:

1. To submit a budget to the Forester of the United States Department of Agriculture (hereinafter called the "Forester") as soon as practicable after January 1 of each year, said budget to show, for the coöperative area covered by this agreement and for the remainder of the State separately, the total estimated expenditures of the State (excluding town and county funds) for all fire protection purposes throughout the current calendar year, said budget to be accompanied by a statement, supplemented with maps if necessary, showing approximately:

(*a*) The watersheds of navigable rivers which are proposed to be protected under this agreement.

(*b*) The location and area of the forest lands on such watersheds which will be protected by the State, municipalities, or private owners; the number of lookout watchmen or patrolmen, with their headquarters, which will be employed by each of these three agencies; the character and extent of other protective measures which it is proposed to put into effect at their expense; and the total estimated expenditure under normal conditions by each of these three agencies.

(*c*) The location and area of the forest lands on such watersheds upon which Federal funds will be expended, and the number of lookout watchmen or patrolmen, with their headquarters, which will be paid from such funds.

(*d*) The periods during which protection from forest fires is proposed under this agreement; and

(*e*) The State funds already appropriated or otherwise available for expenditure for fire protection purposes.

To inform the Forester from time to time subsequent to the submission of the budget of any additional appropriations or sums made available for fire protection during the remainder of the calendar year, or of any reduction in such sums, and of any revision of the budget thereby made necessary.

2. To secure for the Federal men employed under this agreement appointment as Deputy State Fire Wardens or otherwise, without additional compensation, and such police powers for the prevention and control of forest fires as may be granted under the laws of the State of North Carolina;

To employ such men only in localities on the watersheds and areas approved under this agreement and within the season or seasons when normally there is a real fire danger;

To equip them with such fire-fighting tools or devices and authorize them to employ such assistance in fighting fires as State funds and the State fire laws and regulations will permit;

To instruct them in writing as to their duties and supervise their work;

To be responsible for seeing that, during actual danger periods, each Federal employee keeps a vigilant lookout for forest fires and makes every possible effort to have such fires extinguished, whether they occur on lands belonging to the State, the Federal Government, or a private owner, and to see that during other times each such employee, if hired for continuous service, be kept engaged in other fire protection work upon the areas approved under this agreement; and

To make such inspection of the work done under this agreement as may be necessary to promote the effectiveness of said work.

3. To expend the Federal funds (allotted as hereinafter provided) exclusively for the hire of lookout watchmen or patrolmen unless otherwise specifically authorized in advance by the Forester;

To regulate such Federal expenditures so that during any Federal fiscal year they shall not exceed the amount appropriated and expended by the State during the same period for the purpose of protecting from fire forested watersheds of navigable streams in the United States;

To regulate the expenditure of Federal and State funds from month to month throughout the fire season as far as practicable in the proportion of the total Federal allotment to the total State budget for the coöperative area provided for herein, and in the event of the State expenditure throughout the current calendar year falling below said total State budget, the proposed Federal expenditure will be decreased proportionately;

To submit to the Forester, on or before the fifteenth of each month, a statement showing such expenditures from both Federal and State funds during the preceding calendar month, and

To certify by telegram or letter to the Forester, in asking for an increase of allotment or waiver in the manner of expenditure above prescribed, the facts establishing the existence of an extraordinary fire hazard and the need for such increase or waiver.

4. To use every proper means to bring about the active coöperation of the owner with respect to all private forest lands afforded protection against fire under this agreement, including aid from him in the hire of lookout watchmen, patrolmen, or fire-fighters, construction of improvements, and the like.

Article II. The Secretary agrees:

1. To fix the sum to be allotted for expenditure by the Federal Government during any calendar year or during other periods, as the occasion may require, including emergency allotments;

To approve the areas on which such sum or sums shall be expended, and

To stipulate in times of emergency any waiver in the manner of expenditure herein prescribed which he may deem best.

2. To appoint the State Forester a Collaborator in the Forest Service of the United States Department of Agriculture at a salary of one dollar ($1) a month;

To authorize him to select the Federal men employed under this agreement in accordance with a standard of qualifications to be prescribed by the Forester, which is made a part of this agreement and marked Exhibit "A";

To authorize him to employ them, with the approval of the Secretary, at not to exceed ninety dollars ($90) for a thirty-day month, or its equivalent of three dollars ($3) per diem, and to certify such employment on properly executed vouchers to the Fiscal Agent, Forest Service, Washington, D. C., at the end of each calendar or fractional month;

To require him to hire at a *monthly* rate of pay men who are expected to perform continuous service in excess of thirty days;

(The men paid at a monthly rate will receive pay for Sundays and legal holidays* whether or not any service is actually performed on such days, and for days when, because of inclement weather, no outdoor service can be

*January 1, February 22, May 30, July 4, Labor Day, Thanksgiving Day, and December 25.

performed. Men employed and paid by the month may be granted 1¼ days leave with pay for each month of continuous service, beginning with the third month. When such men are absent from duty, except as noted above, such time must be deducted from their salary at the rate of 1/30 of their monthly salary for each day or fraction thereof of such absence from duty.)

To require him to hire at a *daily* rate of pay men who are expected to perform only intermittent service, such as on days of actual fire danger;

(Per diem men must perform service on each and every day for which they receive pay; that when paid for Sundays or legal holidays, service must be necessary and actually performed to which the supervising officer (Collaborator) certifies on the payroll account.)

To give him direct charge of the force of Federal men employed under this agreement, and

To extend to him and the Federal men employed hereunder the use of the United States penalty frank in accordance with the accompanying regulations marked Exhibit "B," which are made a part of this agreement.

Article III. It is expressly understood and agreed between the parties hereto:

1. That the said Secretary or his authorized representative shall have full authority to inspect the protective areas and the forces therein authorized, and at his option, by giving the Board written notice, to withdraw his approval of any such area or portion thereof, or terminate the employment of any Federal patrolmen, lookout watchmen, or fire-fighters or of the State Forester as Collaborator in the Forest Service.

2. That both the Board and the Forest Service of the United States Department of Agriculture shall have equal right to publish the results of the coöperation under this agreement: *Provided*, that any results intended for publication, except press notices of momentary or local interest, be approved by the Board and by the Secretary; and that in all such publications it shall be plainly stated that the results were secured through coöperation between the Board and the Secretary.

3. That this agreement shall become effective as of the day and year first above written and continue in force thereafter, subject, nevertheless, to the availability of funds appropriated by Congress by the Act of March 1, 1911, for the purposes herein mentioned, and to any amendments which may be made hereof by mutual agreement of the parties; and it is expressly understood that this agreement or any modifications hereof may be terminated by either party upon thirty (30) days written notice to the other.

In witness whereof, the said Board has hereunto caused its name and seal to be affixed by its proper officers on the 6th day of March, 1916, and the said Secretary has hereunto set his hand and affixed his official seal on the date below written.

Geological Board,
By Joseph Hyde Pratt,
State Geologist.
J. S. Holmes,
State Forester.
D. F. Houston,
Secretary of Agriculture.

Signed and sealed by the Secretary of Agriculture, this 11th day of March, 1916.

EXHIBIT "A," BEING QUALIFICATIONS FOR FEDERAL MEN EMPLOYED UNDER THE WEEKS LAW

Candidates for appointment as temporary employees during the season of serious danger from fire must be able-bodied and capable of enduring hardships and of performing severe labor under trying conditions; must be able to build trails and cabins and to pack in provisions without assistance; must be thoroughly familiar with the region in which they seek employment (or in other similar regions), including its geography, its forests, and industrial conditions.

Invalids and consumptives seeking light out-of-door employment are not qualified for the work and should not be employed.

Employing officers will require sobriety, industry, physical ability and effectiveness, will give preference to local residents of whose fitness he is fully satisfied, and will employ no person for personal or political considerations.

NATIONAL FOREST RESERVATIONS

In addition to the coöperative work the United States Department of Agriculture is doing in connection with the protection of certain forest areas from fire, that Department has inaugurated a very effective system for protecting from fire the forests of those areas that have been purchased by the Federal Government for National Forest Reservations. The following tables give a general statement regarding the location of areas of forest land that the Federal Government is considering purchasing; the area that has been approved for purchase; and the area already acquired, to June 30, 1916.

INFORMATION AS TO PURCHASE AREAS AND LAND BEING ACQUIRED IN NORTH CAROLINA UNDER THE ACT OF MARCH 1, 1911.

Location of Purchase Area				Approved for Purchase			Acquired		
County	Area	Watershed	Acres	Acres	Price	Value	Acres	Price	Value
Avery	Boone	Catawba	44,411	16,738	$ 1.90	$ 31,802.20			
Buncombe	Mount Mitchell	Tennessee	61,481	11,731	10.60	124,294.00	1,739.44	$ 9.07	$ 15,782.57
Buncombe	Pisgah	Tennessee	20,540	14,994	5.00	74,970.00			
Burke	Boone	Catawba	62,024	19,648	1.90	37,331.20			
Caldwell	Boone	Catawba	72,788						
Caldwell	Yadkin	Yadkin	34,592						
Cherokee	Cherokee	Hiwassee	5,978						
Cherokee	Nantahala	Hiwassee	79,037						
Clay	Georgia	Savannah	16,738						
Clay	Nantahala	Hiwassee	68,012						
Graham	Nantahala	Little Tennessee	184,322						
Haywood	Pisgah	Tennessee	59,805	1,345	5.00	6,725.00			
Haywood	Smoky Mountain	Tennessee	90,915						
Henderson	Pisgah	Tennessee	22,717	20,325	5.00	101,625.00	12,904.06	5.00	64,520.30
Jackson	Pisgah	Tennessee	90,688						
Jackson	Savannah	Savannah	39,457	2,353	8.22	19,331.00	958.87	7.39	7,085.27
McDowell	Boone	Catawba	28,894						
McDowell	Mount Mitchell	Catawba	86,016	48,610	6.60	320,601.25	23,108.10	5.60	129,447.02
Macon	Nantahala	Little Tennessee	126,660	34,540	8.94	308,790.75	30,012.54	9.53	285,946.62
Macon	Savannah	Tennessee	76,121	37,037	7.80	288,539.00	15,920.31	7.54	120,072.38
Madison	Unaka	Tennessee	72,133						
Mitchell	Boone	Catawba	16,806						
Mitchell	Mount Mitchell	Tennessee	17,265						
Mitchell	Unaka	Tennessee	59,036						
Swain	Nantahala	Little Tennessee	30,063	2,170	6.04	13,098.25	1,698.87	5.94	10,094.08
Swain	Smoky Mountain	Tennessee	248,786						
Transylvania	Pisgah	Tennessee	110,600	50,036	5.00	250,180.00	36,799.69	5.00	180,498.45
Transylvania	Savannah	Savannah	43,462						
Watauga	Boone	Tennessee	6,725						
Watauga	Yadkin	Yadkin	30,856						
Wilkes	Yadkin	Yadkin	129,048						
Yancey	Mount Mitchell	Tennessee	69,051	11,870	10.94	129,900.00	9,970.12	10.95	109,203.58
Yancey	Unaka	Tennessee	38,208						
Totals			2,143,235	271,397	$ 6.29	$1,707,187.65	$133,112.00	$ 6.93	$ 922,650.27

There is given below a detailed description of the forest areas in North Carolina that are being considered for purchase by the Federal Government. These descriptions are taken from the Report of the National Forest Reservation Commission, presented to Congress December 8, 1915.

Unaka.—The Unaka area includes 473,533 acres situated on the waters of the French Broad, Nolachucky, Toe, Cane, Watauga, Doe, and Elk rivers, all tributaries of the Tennessee River. It lies along the State line between the States of Tennessee and North Carolina and embraces the rough mountains and high mountain valleys. A small beginning has been made in the purchases in this area, the approved acreage amounting to only 19,756 acres. The forest which originally was of excellent character, containing much valuable oak, chestnut, hemlock, white pine, and poplar, has been largely removed and the young timber and soil have been considerably damaged by fire. The region is in great need of fire protection, and owing to the fact that the timber area lies on the ridges with more or less agricultural land lying between, this problem is one of considerable magnitude. The efforts of the Government in fire protection have already been of value. Where fires have been kept out a very abundant reproduction of such valuable trees as white pine, poplar, chestnut, and oak quickly appear. Owing to the cutting which has gone on, many of the acquired tracts contain only low-grade timber products. These, however, owing to the excellent local market conditions, find ready sale. The region is well supplied with railroads and secondary wagon roads. It is, however, in need of further road development and, most of all, trails to make accessible the remote districts for fire protection and administration. Although there are a few valleys of good agricultural land, this area, for the most part, is typically forest land needing protection from erosion and too rapid drainage. There are a few rounded mountain tops which will make good grazing areas if cleared and put into grass. Ultimately the purchases by the Government should cover at least three-quarters of the lands on this area.

Smoky Mountains.—This area contains the principal part of the Smoky Mountains, which is the largest and most elevated mountain range of the Eastern States. Included in the purchase area are 692,902 acres, of which only 41,265 acres have been approved for purchase. The lands form part of the watershed of the Tennessee River. Timber stands in this region were very heavy and only within the past twenty years has cutting gone on extensively in the higher mountains. A great deal of the virgin timber remains, which fact accounts for the slow progress which purchases have made in the area. Eventually the Government should own the bulk of the lands, as the agricultural possibilities are limited to small coves and valleys, the aggregate of which is not large.

The lands are held in large tracts, many of which are being lumbered at present. Unless they can be bought subject to a reservation of the timber they can not be acquired until lumbering operations are nearing an end. Besides their value for watershed protection and timber production these lands have value for grazing. On the summit of the Smoky Mountains are numerous large grass-covered balds which afford first-class grazing. These are already quite fully utilized. Considerable use has been made of the area for resort purposes and this use promises to grow. The area contains several logging railroads which extend back into the mountain coves, but is wholly lacking in good roads. It also needs a system of trails and telephones to facilitate fire protection. These needs probably can not be met until the Government largely increases its holdings.

Boone.—Protection to important headwater tributaries of the Catawba River is the fundamental reason for this area, which contains 231,648 acres. Merely a beginning has been made in purchases by the approval of one tract of 36,386 acres. Included within the area is a large section of the steep, broken country, which constitutes the southern slope of the Blue Ridge, and many noted topographic features, among them Grandfather, Hawksbill, and Table Rock Mountains and the Linville River, with its scenic falls and gorge. The land is well adapted to timber growth but to no other purpose, the soil being too rocky and steep for agricultural uses. Heavy stands of oak, poplar, hemlock, and white pine were produced originally, but the tract has mostly been cut over and is being acquired subject to timber contracts, which will remove the remaining merchantable stands. The locality is one of high hazard as to fire and erosion. Very serious damage has already taken place at certain points, but with protection the land will reproduce to another stand of timber of the same character as the virgin stand. A great work can be done here by suppressing forest fires and by building up public sentiment against them. It is highly desirable that the Government's purchases be extended to cover practically the whole of the area. Transportation facilities are already good, as a railroad extends into the heart of the Government's purchases, while a well-graded highway extends up the Blue Ridge where it connects with the scenic Yonahlossee Pike, which skirts the northern boundary of the purchased lands between Blowing Rock and Linville. This region is already well advanced as a summer resort region, but is destined to much higher development than at present because of its unsurpassed natural beauties and its accessibility to residents of the Southeastern States.

Mount Mitchell.—This area includes 231,013 acres, of which there has been approved for purchase 75,333 acres. The watersheds drained are those of tributaries of the Catawba and Tennessee Rivers. The area

is notable in including as its central topographic feature Mount Mitchell, which is the highest peak in the Eastern States. It is a region which is largely used for recreational purposes. The assembly grounds of several religious organizations are located within or adjoining this area. Protection of this area and adjacent lands is of more than ordinary importance, since here are located the watersheds from which Asheville and five other towns derive their water supply. The lands which have been assembled are located in two bodies; one, covering the lower slope of the Black Mountains of which Mount Mitchell is the dominant peak, and extending across the valley of South Toe River and including much of the southern slope of the Blue Ridge; the other, covering the western slope of Craggy Mountains, which parallels the Black Mountains on the west. Between these bodies of land lies the protected water supply watersheds of the city of Asheville, covering 17,000 acres, as well as a number of important tracts which should be acquired by the Government. The State of North Carolina has made an appropriation and established a commission to acquire the summit of Mount Mitchell. When accomplished, the State's holdings will probably adjoin and in time may be completely surrounded by the holdings of the Government. The region is of interest for its valuable timber and mineral resources as well as its scenery. The Black Mountains contain one of the largest and most valuable bodies of spruce timber in the Southern Appalachians, and this is now being operated.

So important is fire protection in this general region that an arrangement is being worked out whereby several of the larger private owners and the State will join with the Government in attempting to control fires. On account of the large amount of spruce and the high mountain slopes, which are susceptible to great damage by fire, it is of the utmost importance that the region be kept from burning after lumbering is done. A large amount of virgin timber remains in this area, and the lands which have been acquired by the United States contain a great deal of timber of rather a high value. This area is penetrated by what is known as the central highway, a highway which is nearly completed from the coast to the western portion of North Carolina. There are other roads, but a further development of roads is one of the greatest needs of this section. Additional trails are also required for protection purposes. The rainfall is extremely heavy and erosion is excessive on the mountain slopes wherever the forest cover and the humus are removed. The soils are prevailingly deep loams with excellent productive capacity. In this region many species of vegetation find their optimum growth conditions. In many places the slopes are quite free from stone, but are so steep that it is hazardous to remove the forest and attempt cultivation. The Government should in time acquire all of the Mount

Mitchell area except the lands owned by the State and by the cities, the private lands that are fully protected from fire and held permanently in forest, and the few agricultural valleys.

Pisgah.—The Pisgah area, which comprises 376,760 acres, protects the headwaters of tributaries of the Tennessee River. The lands which have been assembled by the Government occupy the southeastern slopes and foothills of the Pisgah Range, forming a very compact body of 86,700 acres. A large part of this tract is acquired subject to a contract by which the larger timber is to be removed but which will leave standing and protect from fire the trees under 14 or 16 inches in diameter. The area is well covered by a network of roads and trails and is penetrated by an automobile road, which crosses the main ridge and descends to the noted Pink Beds in the heart of the purchased tract. There is a great need for the extension of this road through the Government's holdings. There are some small areas which were once cleared and used for farming purposes but which have reverted to timber. On account of the previous timber cutting, which was done under the direction of a skilled forester, there are to be found excellent stands of young timber which have bright promise for the future. The soils are of good quality and the slopes, which are often steep, are seldom too rocky to produce good stands of timber. On account of the protection which has been given the tract from fire, from unregulated timber cutting, and from grazing for over twenty years the humus is deep and there is no present evidence of erosion. Lying in the heart of the Appalachians and near the city of Asheville there is large use of these lands for health, scenic, and recreation purposes. Although the United States has not yet obtained title to the lands which have been approved, many applications for camps, hotels, and residence sites have already been made. An additional feature of attractiveness lies in the fact that the tract is well stocked with fish and game. The purchases of the Government should be extended to include practically the whole of the purchase areas, as the agricultural lands contained within it are very limited in acreage.

Nantahala.—This is one of the largest of the purchase areas, containing 591,913 acres, and situated entirely upon the watersheds of tributaries of the Tennessee River. In it are situated some of the best and most extensive virgin forests of the hardwood belt. The commission has approved for purchase 36,385 acres in a fairly compact body, which is merely a beginning of the purchases which should be made. The area is characterized by numerous high mountain ranges which are covered by virgin or but slightly culled timber. The forest consists mostly of oak and chestnut on the slopes and ridges and poplar in the coves and more favorable slopes. On the acquired lands is a large amount of valu-

able timber which will eventually bring in much revenue. There is a comparatively small percentage of old fields, but numerous settlements which will take out of the area to be owned by the Government a rather large total acreage. The area as a whole is not well supplied with either railroads or roads. Highways are especially needed for the future removal of products and to make it possible for the local mountain communities to get to market. With better means of access, its exceptional potential value as a recreation ground or summer resort would be transformed into a reality. More trails are also needed in order to protect the tract. In the past there has been much burning of the forest, which has reduced its productiveness materially. Under the efforts of the Government, however, fires are being greatly reduced and a rapid change in sentiment is coming about among the local people through a realization of the damage which forest fires do.

Cherokee.—In the Cherokee area the commission has approved for purchase 135,686 acres out of a total of 222,058. The approved lands are quite compactly assembled except in the northern end of the area. Many of those not acquired have such agricultural value as to render them unavailable for the Government's purposes. The area protects watersheds of tributaries of the Tennessee River. While no mountains of great height are contained within this area, the range in elevation is more than 3,000 feet and the surface is much dissected by long, rather narrow, leading ridges, frequently broken by deep gaps. The prevailing forest is a rather thin stand of pine and oak. In the southeastern portion the timber has in the past been much damaged by sulphur fumes from the copper smelters at Ducktown and Copper Hill. Because of this damage and the continuing hazard the lands in this area have been acquired at a comparatively low price. The area is well served by railroads, being crossed by one line and paralleled by another. A large amount of the merchantable timber which is present on the lands can be hauled to these railroads over short well-graded roads, which, however, it will be necessary to extend up the numerous streams. Owing to the thinning out of the forest by the smelter fumes, there are large areas of mountain ridges stocked with coarse grass which afford some pasturage. Fire and insects have done more than usual damage on this area, probably on account of the low vitality of trees, caused by sulphur fumes.

A lake nine miles in length has been formed by the development of a power company in the southwestern part of the area. In time the land surrounding this lake may have considerable recreational value, as it affords very attractive scenery. Future purchases will be confined to the remaining non-agricultural lands within the area, which probably do not exceed 50,000 acres.

PREPARING THE NORTH CAROLINA FORESTS FOR PRODUCTION AND USE

It is not enough that these forests serve simply to protect the watersheds of the navigable streams. Their usefulness extends in other directions which are of such importance as to make the forests, as their development goes on, an asset of greater and greater value to the Nation and to the State. They should be constantly developed. Their stands of timber should be improved, their soils made more productive, their remote resources made accessible, the water supplies kept pure and at maximum volume, and they ought to be so managed as to serve the public advantageously for recreation and health purposes.

At the bottom of all increase of the resources is protection from fire. Congress now appropriates funds through the Department of Agriculture for the protection, improvement, and administration of these lands. Each area is organized with a protective force under a forest officer and much headway has been made in applying the plans of protection which have been worked out. Less than 1 per cent of the area under protection was burned over during the year, which was an unusually dry and hazardous one. To facilitate plans for protection and administration, 130.25 miles of trail and 81.65 miles of telephone have been constructed and boxes of fire tools located at convenient points. Protective forces have been organized with which to combat fires, and every means has been taken to crystallize local sentiment against this worst of all enemies to the forest. In a number of cases the protective plans correlate with plans for the protection of contiguous forest lands owned by individuals.

The response of the mountain communities to the effort to overcome fires has been gratifying. As a rule the larger timberland owners have joined heartily in the movement, as have many of the farmers. Every year marks a gain not only within the purchase areas but for some distance outside of them.

The several purchase areas have been combined with certain national forests in a new administrative district under the jurisdiction of the Forest Service, and henceforth their management will become that of the national forests. Business is developing upon them in the form of timber sales, grazing, and occupancy of the land for other uses consistent with the general purpose.

High development of the forests for watershed protection and timber production will call for the removal, when there is a market for it, of the mature and the defective timber. The ground must as soon as possible be covered with young thrifty timber of the better kinds and in the densest stands. The culled lands are especially in need of an improvement cutting which will remove the deteriorating material as well as such

mature growth as can be spared from the forest without impairing its protective influences. Where cutting is done the timber is sold on the stump to the highest bidder and cut under the rules and regulations of the Secretary of Agriculture.

Good roads are greatly needed on these lands and it appears to be the duty of the Federal Government to contribute to their construction. States and counties in the regions in which the areas are situated have been active in road building. Frequently improved highways extend to the edge of the Government's holdings. It seems to be a responsibility properly belonging to the government to carry these highways across its own lands. Such highways will nearly always facilitate the general development plans which are being worked out on the areas and make it possible for the public to use the mountains largely and conveniently.

There is a growing tendency on the part of the public to go to the mountains for pleasure, health, and recreation. Many of the tracts which are being acquired have attractive scenery and afford delightful places for recreation camps and summer homes and hotels. Many of these places are too inaccessible to be reached until roads can be built to them. The most insistent demand, however, is for roads by which the public may travel through the mountains and derive the benefits of mountain air and scenery and yet stop at hotels in the towns or return over considerable distances to their homes.

Even though the counties are to receive 25 per cent of the proceeds of the forests for school and road purposes and an additional 10 per cent is to be spent on roads and trails within the forests under the direction of the Secretary of Agriculture, these funds will not be sufficient to construct the highways which are needed.

The total improvements made on these Forest Reservations by the Federal Government to June 30, 1916, are as follows:

Total Improvements to June 30, 1916		*Approximate Value*
Total number miles of road constructed	4.50	$ 250.00
Total number miles of trail constructed	130.25	7,599.00
Total number miles of telephone line constructed	81.65	3,926.00
Total number miles of fire break constructed	10.12	156.00
Total number miles of fence constructed	5.90	199.00
Total number lookout structures	1.00	50.00
Total number dwellings	43.00	1,371.00
Total number barns	27.00	172.00
Total number other buildings	11.00	775.00
Total value		$ 14,498.00

Grazing has been permitted on the Forest Reservations, and during the year ending June 30, 1915, 83 grazing permits were issued for 719

head of cattle, 18 horses and 81 hogs. During this same period 24 grazing permits were issued for 226 sheep. For the fiscal year ending June 30, 1916, 99 permits were issued for 637 head of cattle, 20 horses and 57 hogs; and 12 grazing permits for 59 sheep.

Special permits for use of certain lands in the Forest Reservation were issued as follows:

Permits and Easements Issued During Fiscal Year 1915

Charge permits	33
Free permits	4
Total	37
Acreage under special use	373.70
Miles under special use	.53

The above permits were issued for the use of Agricultural Land, Pasture, Fruit, Dragway, Cemetery, Drift Fence, a corn mill and residences.

There was also a certain amount of timber sold from these areas. The total receipts from the North Carolina National Forest Reservations for the two years 1915-16 were $3,389.02, as follows:

NORTH CAROLINA RECEIPTS

1915

Timber sales	$ 485.92
Grazing	777.71
Special use	304.38
Fire trespass	36.85
Total	$1,604.86

1916

Timber sales	$ 805.82
Timber trespass	62.50
Grazing	623.82
Special use	292.02
Total	$1,784.16

OTHER ACTIVITIES OF THE UNITED STATES FOREST SERVICE IN NORTH CAROLINA

1. The study of cutover areas in the Southern Appalachians was begun by E. H. Frothingham in 1915 as a part of a general project embracing similar studies on National Forests in the West with the object of determining reasons for success or failure of reproduction following the different kinds of past cutting, and applying the data thus obtained to the formulation of rules for cutting and management on the new purchase areas. The study was by means of measurements of small temporary sample plots located in cutover areas exemplifying

different kinds of cutting and different types of forest. About 25 such plot tallies were made in North Carolina on the Mt. Mitchell Purchase Area and Pisgah National Forest. The study is not yet completed.

2. The investigation of factors contributing to the damage from the heavy flood of July, 1916, was participated in by E. H. Frothingham and L. J. Young, representing the Forest Service, who studied chiefly the relation of forest conditions to run-off, the formation of land slides, and the contribution of debris to the streams. A month was spent on this work, and a joint report prepared, the disposition of which has not yet been finally decided upon.

3. Under agreement between the Forest Service and the Biltmore Estate four sets of permanent sample plots were established in plantations on the Estate. Each set consists of a thinned and one or more control plots, the object of the study being to observe periodically the effects of the first and of subsequent thinnings. It is expected that more plots will be established in other plantations in the Biltmore Estate this year.

4. The woodlot economics survey consists of a set of records from each of 67 farms in the northern half of Randolph County, which give data on the relative value of the land for agriculture, grazing, and timber growing. These records contain figures on the area and value of the farms, distance to market, different classes of land, character, area, quantity and value of timber, use of timber for protection, and the woodlot for pasture, quantity and value of woodlot products used at home and those sold; whether woodland on farm is suitable for cultivation, and will be cleared in time or not; work done in woodland; the annual expense of keeping it; and other similar questions. This data will be worked up with corresponding information from 15 other representative localities in the eastern United States, possibly for publication. The project is not yet completed.

FOREST FIRES

In order to secure as reliable information as possible relating to the damage done to our forest areas by fires, and at the same time to interest the leaders of thought in our various townships in fire prevention, annual inquiries have been made each year by correspondence with special agents in these townships, asking for information as to number of fires, damage done, cause of fire, etc. A circular letter and set of questions were prepared which were sent to over 1,500 correspondents throughout the State. A copy of the circular letter and questions are given below:

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY
FORESTRY DIVISION

CHAPEL HILL, N. C., January 1, 1916.

DEAR SIR:—The Survey is anxious to continue its practice of gathering information on forest fires from every township in the State. Such information has been furnished by responsible and public-spirited citizens, because they have realized that the present and future welfare of North Carolina will be greatly advanced by such efforts.

Will you please answer the enclosed list of questions for your own township as well as you can, and return to me in the enclosed stamped envelope as soon as possible?

The information furnished by our voluntary correspondents last year has been compiled and published in Economic Paper 40, "Forest Fires in North Carolina During 1914, and Forestry Laws of North Carolina," a copy of which I will be glad to send you upon request.

Very truly yours,

JOSEPH HYDE PRATT,
State Geologist.

J. S. HOLMES,
State Forester.

FOREST FIRES IN NORTH CAROLINA DURING 1915

REPORT OF TOWNSHIP CORRESPONDENTS

1. To what township (or townships) of what county do the statistics given below apply?
   .....Township .....County
2. How many different forest fires have you had during the year 1915? . . . .
3. What was the total acreage burned over in these townships during the past year? . . . .acres
4. How much merchantable standing timber has been destroyed by fire during 1915? Give amount in board feet, ...bd. ft.
5. What was the approximate value of this timber as it stood? . . . . . $.....
6. How many acres of young growth, not yet salable, has been destroyed? . . . .acres
7. What was the approximate value of this young growth? . . . . . $.....
8. What is the value of all forest products, such as sawlogs, lumber, ties, etc., that were destroyed by forest fires during 1915? . . . . $.....
9. What is the value of all improvements, such as fences, barns, houses, mills, etc., and of live stock, that were destroyed by forest fires during 1915? . . . . . $.....
10. State as close as possible what it has cost private individuals, lumber companies, and others to fight forest fires in your county or township, $.....
11. In what month or months did the fires occur?.....

12. What were the causes of the forest fires? State number resulting from each cause.

Brush Burning,	.....	Incendiary,	.....
Hunters,	.....	Lightning,	.....
Campers,	.....	Miscellaneous,	.....
Railroads,	.....	Unknown,	.....
Lumbering,	.....		

13. Has any one, as far as you know, been prosecuted for setting fire to forests in your county or township the past year?
If so, with what result?.....
.....
Name of Correspondent: .....
Postoffice: .....

From the replies sent in by these special agents, statistics are compiled regarding the damage done by forest fires, and their causes. Very satisfactory replies have been received and the information obtained is very creditable. I believe the collection of these forest fire statistics for the past four or five years and the publication of the results, giving not only loss by forest fires but the causes of the fires, was one large factor in creating a sentiment in favor of the Forest Fire Bill. These statistics have been prepared as reports of the survey which are published in the series of economic papers of the survey publications. The report for 1914 was prepared for Economic Paper No. 40. The 1915 report has not yet been published, owing to the very material reduction of our printing appropriation. This, together with the report for 1916, will be included in an economic paper soon to be issued.

The United States Forest Service's report of forest fires in the National Forest Reservations was as follows:

NATIONAL FOREST FIRES

CALENDAR YEAR 1915

Total number of fires	97
Classification of Fires	
Under one-fourth acre	30
Under 10 acres	19
Damage less than $100	41
Damage between $100 and $1,000	6
Damage over $1,000	1
Total	97
Fires originating on National Forest land	49
Fires originating on private lands inside National Forest	11
Fires originating outside forest, entered forest	12
Fires originating outside forest confined to outside areas	25
Total	97

Total area of National Forest land burned over (acres)	1,830
Total amount timber damaged or destroyed (board feet)	279,000
Total value of timber destroyed	$ 218.00
Total damage to reproduction	$1,372.00
Total damage to forage	$ 11.00
Total loss	$1,601.00
Area of private land within National Forest burned over (acres)	5,148
Amount of timber damaged or destroyed (board feet)	370,000
Total value of timber destroyed	$ 370.00
Total cost of fighting fires	$ 677.43
Cost of fighting fires on National Forest land	$ 338.00
Cost of fighting fires on all other lands inside National Forest boundaries threatening National Forest lands	165.62
Cost of fighting fires outside National Forest boundaries threatening National Forest lands	173.81
Value of coöperation	$ 677.43

Causes of Forest Fires

Railroads	24
Lightning	2
Incendiary	11
Brush burning	8
Camp fires	7
Lumbering	30
Unknown	11
Miscellaneous	4
Total	97

The comparatively small damage done by the ninety-seven fires is due to the systematic method employed by the United States Forest Service in patrolling and protecting the National forests.

The value to the State of these annual studies has recently been greatly reduced by its failure to have the reports printed and distributed. The people must know conditions before they can be expected to correct them.

The forest fire laws, together with explanations as to their value and the manner of their enforcement have been published and widely distributed. The Survey has also printed and distributed large placards for posting in public places, calling the attention of the people to the provisions of these laws and warning them against forest fires. Copies of these placards are given as follows:

HELP! HELP!

The Co-operation of all Good Citizens is asked in the Prevention of

FOREST FIRES

Fires kill or injure standing timber.
Fires destroy all the valuable young growth.
Fires burn up cordwood, fences and much other property.
Fires very seriously injure the soil.
Fires cause untold waste.
Forest fires in North Carolina are destroying $650,000 worth of property each year.

THEREFORE HELP PREVENT FOREST FIRES

Don't burn brush or grass during dry, windy weather.
Don't leave camp fires burning.
Don't toss away burning matches or tobacco.
Don't make a camp fire against a rotten tree or log, where you can't be sure it is out.

In order to assist citizens in protecting their land from fire, the New Forestry Law declares the following acts to be misdemeanors:

Leaving any fire before it is extinguished.
Setting fire to grass land, brush land or woodland, except it be one's own property.
Setting fire to one's own woods without notifying adjoining owners.
Kindling a camp fire until a sufficient space has been cleared off around it.
Leaving a camp fire without fully extinguishing it.
Accidentally or negligently starting a fire without extinguishing it.

It is also against the law to set fire to or BURN ANY BRUSH, GRASS or OTHER MATERIAL or to burn any TAR KILNS or PITS OF CHARCOAL whereby any property may be endangered or destroyed, without keeping a competent watchman in charge while burning. (*Public Laws of North Carolina, 1915, Chapter 243, Sections 8, 9 and 10*).

For information concerning the forest laws, write the

STATE FORESTER,
CHAPEL HILL, N. C.

APPROVED BY THE STATE GEOLOGICAL BOARD.

READ THE NEW LAW

FOR THE PREVENTION OF

FOREST FIRES

(Chapter 243, Public Laws of North Carolina, 1915.)

WOODS MUST NOT BE SET ON FIRE.

Sec. 8. If any person shall intentionally set fire to any grass land, brush land, or woodland, except it be his own property, or in that case without first giving notice to all persons owning or in charge of lands adjoining the land intended to be fired, and also taking care to **watch such fire while burning** and taking effectual care to **extinguish such fire** before it shall reach any lands near to or adjoining the lands so fired, he shall for every such offense be guilty of a misdemeanor and shall be fined not less than ten dollars, nor more than fifty dollars, or imprisoned not exceeding thirty days. This shall not prevent action for damages sustained by the owner of any property from such fires.

CAMP FIRES MUST BE EXTINGUISHED.

Sec. 9. Any wagoner, hunter, camper, or other person who shall kindle a camp fire or shall authorize another to kindle such fire, unless all combustible material for the **space of ten feet** surrounding the place where said fire is kindled has been removed, or shall leave a camp fire **without fully extinguishing it,** or who shall accidentally or negligently by the use of any torch, gun, match, or other instrumentality or in any manner whatever **start any fire** upon any grass land, brush land or woodland without fully extinguishing the same, shall be guilty of a misdemeanor and upon conviction shall be punished by a fine of not less than ten dollars, nor more than fifty dollars, or imprisoned not exceeding thirty days.

ALL FIRES MUST BE CAREFULLY WATCHED.

Sec. 10. All persons, firms, or corporations, who shall burn any tar kiln or pit of charcoal, or set fire to or **burn any brush, grass, or other material,** whereby any property may be endangered or destroyed shall keep and **maintain a competent and careful watchman** in charge of said kiln, pit, brush, or other material while burning. Any person, firm, or corporation violating the provisions of this section shall be punishable by a fine of not less than ten dollars nor more than fifty dollars, or imprisoned not exceeding thirty days. Fire escaping from such kiln, pit, brush, or other material while burning shall be prima facie evidence of neglect of these provisions.

For further information concerning the Forest Law, write the

STATE FORESTER,

CHAPEL HILL, N. C.

APPROVED BY THE STATE GEOLOGICAL BOARD.

HUNTERS AND FISHERMEN

LOVE THE WOODS

THEREFORE

THEY WILL WANT TO ASSIST IN

PROTECTING THE WOODS FROM FIRE

They Should Remember the Woodsman's Rules:

DO NOT throw away lighted matches.
RUB OUT your cigarette stumps or hot pipe ashes.
BUILD small fires. Build them on bare ground where they will not run.
DO NOT make a fire against a dead tree, log or stump.
DO NOT kindle a fire in a hollow tree.
NEVER LEAVE a fire until it is out.

Be Careful With Fire

For information concerning the Forest Law, write the

STATE FORESTER,

APPROVED BY THE STATE GEOLOGICAL BOARD

CHAPEL HILL, N. C.

ARE YOU
Farming With Fire?

If you are cleaning up or clearing land
and wish to burn brush or grass

Use the Utmost Caution

to Prevent the Fire from Escaping

CHOOSE a damp, still day---or better, a still evening---
for burning.

WATCH the fire carefully.

HAVE ENOUGH HELP to control the fire.

DO NOT LEAVE until all fire is entirely out.

The new law reads:

Section 10. All persons, firms, or corporations who shall burn any tar kiln or pit of charcoal, or set fire to or **burn any brush, grass, or other material,** whereby any property may be endangered or destroyed, shall keep and **maintain a careful and competent watchman** in charge of said kiln, pit, brush, or other material while burning. Any person, firm, or corporation violating the provisions of this section shall be punishable by a fine of not less than ten dollars nor more than fifty dollars, or imprisoned not exceeding thirty days. Fire escaping from such kiln, pit, brush, or other material while burning shall be ***prima facie*** evidence of neglect of these provisions.

—Chapter 243, Public Laws of N. C., 1915.

For further information concerning the Forest Law, write the

STATE FORESTER,

CHAPEL HILL, N. C.

APPROVED BY THE STATE GEOLOGICAL BOARD

CAMPERS AND WAGONERS

ARE REQUESTED TO

Take Every Precaution

to prevent fire escaping from their

CAMP FIRES

REMEMBER:

To rake a place bare for your camp fire before lighting it.
Not to build your camp fire against dry logs, stumps or trees.
To make a small camp fire.
Never to leave camp until your fire is quite out.

THE NEW LAW READS:

Section 9. Any **wagoner, hunter, camper,** or other person who shall **kindle a camp fire** or shall authorize another to kindle such fire, unless all combustible material for the **space of ten feet** surrounding the place where said fire is kindled has been removed, or shall **leave a camp fire without fully extinguishing it,** or who shall accidentally or negligently, by the use of any torch, gun, match, or other instrumentality, or in any manner whatever start any fire upon any grass land, brush land or woodland, without fully extinguishing the same, shall be guilty of a misdemeanor, and upon conviction shall be punished by a fine of not less than ten dollars nor more than fifty dollars, or imprisoned not exceeding thirty days.—Chapter 243, Public Laws of N. C., 1915.

For further information concerning the Forest Law, write the

STATE FORESTER,

APPROVED BY THE STATE GEOLOGICAL BOARD

CHAPEL HILL, N. C.

HELP PROTECT OUR FORESTS!

BE as careful with ALL FIRE in the Woods as you are in your Own Home

You and your children can escape from fire, but the trees can not get away---

GIVE THE LITTLE TREES A CHANCE

On them, as on your children, does the future depend

DO NOT let fire get out

EXTINGUISH the Small Fire before it becomes a large one

For Copy of the FORESTRY LAW write the STATE FORESTER, CHAPEL HILL, N, C.

Approved by the State Geological Board

POSTER NO. 6

☛ SAFETY FIRST ☚

DON'T drop burning matches, or cigarettes, in the woods

BE SURE to Extinguish your Camp Fire

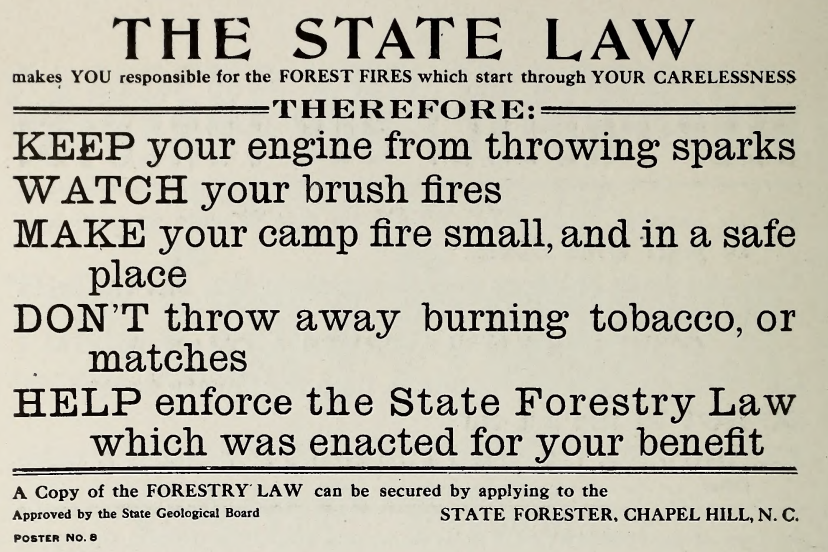
WATCH your burning brush, grass, or rubbish until it is quite out

HELP prevent and extinguish forest fires

A Copy of the FORESTRY LAW will be sent you FREE upon application

Approved by the State Geological Board STATE FORESTER, CHAPEL HILL, N. C.

POSTER NO. 7


THE STATE LAW
makes YOU responsible for the FOREST FIRES which start through YOUR CARELESSNESS
THEREFORE:
KEEP your engine from throwing sparks
WATCH your brush fires
MAKE your camp fire small, and in a safe place
DON'T throw away burning tobacco, or matches
HELP enforce the State Forestry Law which was enacted for your benefit
A Copy of the FORESTRY LAW can be secured by applying to the
Approved by the State Geological Board
STATE FORESTER, CHAPEL HILL, N. C.
POSTER NO. 8

In September, 1915, the Forester made a study of the fire conditions along the Southern Railway in company with Mr. Ellers Koch of the United States Forest Service. As a result of this investigation, it is believed that the Southern Railway will take up more intensive fire protection along its lines.

TIMBER SUPPLY OF NORTH CAROLINA

The systematic study of the forest conditions of North Carolina which was started in 1909 was continued for only a short time during the past two years on account of lack of funds. This investigation is to ascertain as closely as possible the timber supply of the State and should be continued until all the counties have been examined. By keeping account of the timber cut from year to year it is possible for the Survey to keep a fairly accurate record of the timber supply in the State from year to year. This work has been done in coöperation with the United States Forest Service.

Up to the present time the following counties have been investigated and reports of the timber resources published as press bulletins:

Cherokee, Clay, Macon, Graham, Swain, Jackson, Haywood, Transylvania, Henderson, Buncombe, Madison, Yancey, Mitchell, Avery, McDowell, Rutherford, Polk, Cleveland, Gaston, Lincoln, Catawba, Alexander, Caldwell, Watauga, Ashe, Alleghany, Wilkes, Surry, Yadkin,

Iredell, Mecklenburg, Cabarrus, Rowan, Davidson, Davie, Forsyth, Stokes, Rockingham, Guilford, Randolph, Montgomery, Stanly, Caswell, Alamance, Chatham, Lee, Wake, Durham, Orange, Person, Granville, Vance, Warren, and Franklin.

The remaining counties should be examined at once and it is hoped that sufficient funds can be made available for this purpose during the next fiscal year.

EXAMINATION OF FOREST LANDS, FARM WOODLOTS, AND CUT-OVER LANDS.

During the past two years several areas of forest lands, cut-over lands, etc., were examined by the Forester and recommendation made in regard to handling the lands. As these reports are more than of purely local interest they are given in full below:

REPORT ON LAKE LATHAM FARM, NEAR MEBANE, ALAMANCE COUNTY, NORTH CAROLINA.

August, 1916.

Description.—Lake Latham Farm is situated two miles west of Mebane, on the Southern Railway. It consists of about 850 acres of land, about 250 of which is cleared, and the balance covered with a variety of forest growth. Mr. J. E. Latham, of the J. E. Latham Company, cotton merchants, Greensboro, N. C., is the owner.

Object of the Owner.—Mr. Latham is greatly interested in live stock and already has a nice herd of pure-bred Hereford cattle. He wishes to make this a live stock farm and so is anxious to extend the pasture area to a considerable extent. He hoped that it might be possible to clear out some of the poorest timber and the undergrowth, leaving the better timber on the ground and using the areas for improved pasture. On some areas he expects to sow grasses and clover, without plowing or otherwise breaking the ground, letting them be mixed with the native grass already there; but he wishes to know whether it would pay to leave the large growth of cedar, dogwood, birch, oak and other trees, selecting the most vigorous young trees for this purpose.

(1) *Pasture Woods.*—Along a small branch and on the gentle slopes each side, but especially to the south, is a thrifty, though scattered growth of young poplar and pine, chiefly shortleaf, 12-18″ in diameter. Amongst this is an undergrowth of dogwood, oak, alder, etc. This tract is now being used for pasture, but only where the undergrowth has been cut out and the large trees are very scattered is there any amount of pasture.

It is recommended that this area be cleared, leaving small groups of the best trees in the roughest places for the benefit of the live stock. The grasses and clover will only grow to advantage in the open areas.

(2) *Brush Woods.*—There is a dense secondgrowth woods of some 25 or 30 acres, to the west of the barn, composed of sprout and seedling growth of oak, hickory and pine, chiefly shortleaf. It was proposed to thin this out, leaving the better hickories, white oaks, and dogwoods to develop into timber. An effort has been made on a corner of this tract, to clear it by pulling up the young trees with a gasoline traction engine. The cost of this method was found to be prohibitive, amounting to $30 an acre or more. It is recommended that if this area is to be cleared, all the trees be taken except such as may be needed for shade for the cattle. The trees are all so small that a thinning sufficiently heavy to allow the growth of pasture grasses would let in so much light that the trees left would become worthless for timber. Most of the young hickories are even now in a very much damaged condition from fire, insects, etc.; the dogwood is of such slow growth that it would not pay to leave it for timber.

(3) *Lake Latham.*—There is a considerable area of second growth pine, varying in diameter up to 15″, on the farther side of Lake Latham, which, though not a full stand in every particular, is a satisfactory one; the trees are thrifty and are rapidly becoming valuable for timber. It was suggested that this might be thinned with advantage. However, the trees are in most places quite far enough apart for their rapid development, and thinning would probably result in injuring the timber. It was also suggested that most of the open areas might be planted up. These areas, however, will seed up rapidly where the opening is large enough for the sun to come in; where they are not large enough for this, planting would be of little use as the trees would not grow to advantage.

Adjoining this area is an old field grown up in dense pines, almost pure shortleaf, varying from 2—4″ in diameter. The part of this which was seen was almost a perfect stand. Thinning it would not pay unless a market was available for the wood which would be cut out; it was, therefore, recommended to hold it as it is.

These two areas are close to a picnic ground on the shore of the lake; the risk, therefore, from fire is very great. The leaves have been raked up on the picnic ground in order to provide against fire getting started; in addition, it was recommended that in dry times a man be delegated to watch all picnic parties while on the grounds and to warn them about the danger of fires. It is further recommended that notices warning against fire be posted on the picnic grounds and at other places on the farm. These can be furnished by the State Forester.

(4) *Creek Bottoms.*—Part of the farm is one mile farther northwest, extending for some distance along the bank of Back Creek. The lands along this creek are so valuable for pasture that it will not pay to leave any of them for growing timber; however, on areas that are liable to wash or are too rough to put into pasture, the timber should be left. There are some small areas of willow ash, sycamore, etc., which are, at the present time, too wet to be cultivated. Where they can be drained, however, it will not pay to leave the timber.

(5) *Washed Hillsides.*—On this part of the farm are considerable areas of very seriously eroded fields. These have grown up in pine and other trees, but have not even yet stopped washing. Where it is desired to clear these hills, trees that are growing in the washes or on the edges of the gullies, it should be remembered, will be more effective in preventing washes than if cut down and laid in the gullies. The brush cut from near-by areas should be piled in the gullies to assist in stopping the wash. Most of these areas are covered with mixed growth of scrub or "spruce pine," the shortleaf pine, varying up to 12" in diameter. The "spruce pine" might be cut from near-by unwashed areas and used for stopping the washes where it is not desired to cut down all the trees. In this way the better quality shortleaf pine will be left to reseed, and the inferior "spruce pine" will not be allowed to reproduce itself.

Conclusion.—As a general principle, where land can be used for agricultural purposes it will not pay to keep it for the purpose of growing timber. This is especially true of land exceeding ten or twelve dollars an acre in value. To grow the best quality and largest amount of pasture the land should be entirely devoted to this purpose, as trees exclude the sunlight and take up from the soil a large amount of moisture, both of which are essential to pasture. It is therefore recommended that areas which are needed for pasture be cleared so as to allow the production of the largest amount of pasture, leaving only sufficient timber to furnish shade for the live stock. On the other hand, where the land is not needed for pasture or cultivation, timber should be grown even though the land be of considerable value. In this way a good use is made of the land until it shall be needed for some other purpose, while washing is prevented.

J. S. Holmes,
State Forester.

Approved:

Joseph Hyde Pratt,
State Geologist.

REPORT ON THE FOREST TRACT OWNED BY THE CRANBERRY IRON AND COAL COMPANY, CRANBERRY, N. C.

February, 1916.

This property, consisting of some 3,700 acres, lies on the waters of Elk Creek, which flows north into Watauga River just above Butler, Tennessee. The East Tennessee and Western North Carolina Railroad, from Johnson City to Cranberry, enters the property; and the Linville River Railway, from Cranberry to Montezuma, passes through the property for two or three miles. Years ago an iron furnace was operated on the property, and about half of the tract has been cut over for the purpose of making charcoal to supply the furnace. The cutting of the timber for this purpose ceased some twenty years ago.

An effort has been made, with considerable success, to keep fires out of the second growth forests which have resulted from the cutting. In consequence, the woods are in good condition and the young growth has in many cases made exceptional growth. Fine young stands of chestnut, poplar and other species are found, in some places almost pure but in most places mixed, and varying in age from 20 years up to 80 or 90 years. This is perhaps the best example of even-aged, second-growth, hardwood forest to be found anywhere in North Carolina.

Some cutting has been done from time to time, chiefly for the use of the estate. The owner now wishes to thin out the chestnut stands, doing a certain amount each year, with the two-fold object of getting some return from the property and of improving the remaining stand. This latter object is the first consideration in cutting.

The chestnut is largely coppice growth, a number of trees growing out from each stump. Many of the smaller poles are dying because shaded by the larger ones. It is recommended that all dead, crooked, fire-scarred, or otherwise damaged trees, shall be taken out and used for telephone poles or chestnut extract cordwood, leaving only one thrifty tree to the stump. In some cases all the poles on the stump may be cut, provided there are satisfactory trees near-by which will not be left too much separated. Thinning should be done in such a way that the trees left will close up the open spaces with their branches in about five years. A heavier thinning than this would cause the trees to form side branches and stop the growth in height, both results to be avoided. Care should be taken to select for leaving those trees which will largely increase in value. It will not pay to take out trees which will double in value in the next ten years. Small, thrifty poles, which now would make small telephone poles, will, under the proposed system of thinning, become large poles in ten years' time, and will be worth at least twice as much then as they are now.

Sell for poles now only those that are in the way of other thrifty poles; or those that have a crook 20-25 feet up, which would prevent their ever making high-priced poles. Older stands, ranging from 40 years and up, may be made to furnish some large-sized poles by cutting for openings and groups. Openings made by the removal of several large trees will let in sufficient light to start and sprout reproduction from the stumps and seedling reproduction from the surrounding trees. The remaining groups surrounding the openings may consist of smaller trees thinned around as in the younger stands, or partly composed of other species, such as poplar, linn, or red oak.

Unless the land is to be cleared chestnut should never be cut in the summer or fall. By summer cutting the stumps are so weakened that the sprouts growing from the stumps will be weak and the resulting crop of sprouts inadequate to form a thrifty second crop of poles. Cutting should not be done later than May, certainly not later than June; it may begin in the fall as soon as the leaves begin to turn color.

Poplar trees can be left closer than chestnuts, as they grow in height more readily. Thinning poplar too heavily will result in a shorter tree and very likely in having more limby and knotty boles. Where mixed with chestnut, poplar should be favored at the expense of the chestnut, as it will in all probability be more valuable.

Black birch is being sold to a man who will cut it and use the whole tree for distillation. This taking out of the black birch will be of advantage to the forest, as it will give more room to the poplar which usually grows with it. It would probably pay to have it removed even though no cash returns were realized. The distillers should be cautioned about fire and watched pretty closely to see that they are careful.

J. S. Holmes,
State Forester.

Approved:

Joseph Hyde Pratt,
State Geologist.

EXAMINATION OF DYING PINES ON THE PROPERTY OF THE FLEET SCHOOL, FLAT ROCK, HENDERSON COUNTY, N. C.

At the request of the owner, Mr. J. S. Fleet, Headmaster, the State Forester visited a large grove of second growth pine on the school grounds of the Fleet School for Boys, Flat Rock, N. C., during September, 1915. The grove covered two or three acres and included trees of white pine, shortleaf pine, and pitch pine; though white pine was the most abundant tree and the one chiefly attacked. Many trees were quite dead, and others were in the various stages of insect infestation. The

owner had already started to cut the trees, hauling off the wood for fuel and burning up the laps. The work of the pine bark beetle was very evident, and the steps already taken to dispose of the dying and dead trees were approved. Specimens of the bark and insects were taken and submitted to the Division of Forest Insect Investigations in Washington. A letter from Dr. A. D. Hopkins in regard to the samples contained the following information:

"The specimens of wood and bark show the work of *Dendroctonus frontalis*, *Ips avulsus*, and *Pityogenes* sp. While the *Ips avulsus* will sometimes kill small trees, I think the trouble must be caused by the southern pine beetle (*Dendroctonus frontalis*). Control work should be carried on according to instructions in Farmers' Bulletin 476 on the southern pine beetle, care being taken to cut and bark or burn the principally infested trees, remembering that trees which have been dead two or three months or more are not infested."

The directions contained in the Bulletin mentioned were submitted to Mr. Fleet. These include the cutting of infested trees during the winter months and destroying the over-wintering broods in the bark of the main trunks.

This is the first instance which has come to the knowledge of the Survey in which white pines have been so seriously attacked by the pine bark beetle. It is to be hoped that the control measures so promptly put into force, together with the watchfulness of neighbors who are alive to the situation, will prevent any spread of this pest in the white pines which are of so much value to this part of North Carolina.

EXPERIMENTS IN PRACTICAL FORESTRY

Under the law of 1915 (Chap. 253), the General Assembly recognized the duty of the State to experiment in and demonstrate practical methods of forestry. One of the most pressing needs at the present time is to determine what are the best ways of reforesting the non-agricultural lands of the different regions of the State. Through the coöperation of Dr. L. B. McBrayer and the Board of Directors, part of the tract controlled by the State Sanatorium for the Treatment of Tuberculosis in Hoke County has been set aside for the use of the Survey in conducting experiments along these lines. Some seed has already been sown in experimental plots, and it is planned to continue work there next spring on a much more extended scale. The State should acquire areas in other regions where similar experiments can be conducted.

The agreement between the State Geological and Economic Survey and the State Board of Health regarding the administration of the 300 acres of the Sanatorium land is as follows:

CHAPEL HILL, N. C., April 15, 1916.

DR. L. B. MCBRAYER,
State Sanatorium for Tuberculosis,
Sanatorium, N. C.

MY DEAR DR. MCBRAYER:—Mr. Holmes has reported to me the results of his visit to the property owned by the State in connection with the Sanatorium under your charge, and has given me his ideas of what might be done in the way of experimenting in forest regeneration and of improving the Sanatorium property. Mr. Holmes reports that the northwestern side of the tract is not only most suitable for the experiments under consideration, but that you would prefer to have this part of the property used for such purposes because you could turn over to our use a larger amount of land there.

If the Survey went into this project, it would need as much as 300 acres, extending all along the northwestern boundary of the property, including a section of the railroad and of the public road. The road and railway are necessary in order to experiment on the prevention of fires along railroads, and so that the results of the experiments will be given as wide publicity as possible.

It takes so long to secure results from forestry experiments that it seems essential that the Survey should be guaranteed control of their area for a period of twenty-five years; undertaking experiments for a shorter period would, to a large extent, be waste of time and effort.

The scope of the work would necessarily depend on the appropriations made to the Survey by the General Assembly; the Survey could not guarantee to spend any definite amount upon experiments or improvement work, which, however, would be carried on as far as the money available would permit. Such experiments would include natural and artificial regeneration of long-leaf pine, loblolly pine, and other trees suitable for reforesting in the sandhill region; it would especially deal with the question of fire prevention and the results of annual burnings for protective purposes. It would, as time went on, deal with the question of thinning, and of cutting the young timber; this latter, however, could not be started for some years to come, until there was timber large enough to thin and to cut.

The Survey would be unable to spend any money on improving the rest of the property, but would be glad to plan and advise with you and your successors as to methods of improvement, and to supervise such forestry work as you might wish to undertake.

I feel that the people of the State would be greatly benefited by the results of such experiments, and that the Sanatorium property would be very much improved by securing an adequate stand of young, thrifty trees, which would enhance the sale value of the property and make it much more attractive for its present purpose.

Very sincerely yours,

JOSEPH HYDE PRATT,
State Geologist.

SANATORIUM, N. C., April 18, 1916.

DR. JOSEPH HYDE PRATT,
State Geologist,
Chapel Hill, N. C.

MY DEAR DOCTOR:—Yours of April 15th received, and I am very much pleased that you are willing to take up the work of reforestation of some of

the Sanatorium property. I feel reasonably sure that we can give you the 300 acres for that purpose, and we can also arrange for this to cross the highway and the railway.

I notice what you say in regard to the control of park property for twenty-five years, and I see no reason why this could not be granted. Would thank you to write me by return mail, advising me whether you want a written agreement signed by the president of the board, and if so, I will have the same arranged for you at the meeting Friday. Of course in case it so happened that you got out of money and abandoned the work we would want to terminate the contract.

We also appreciate very much your offer to help us in forestry work on the remainder of the place, as far as professional advice is concerned. We note also that you say you feel that this will be a great benefit to the people of the State. Will say that if we can carry out your suggestions it will be in line with our policy since we have been in charge of this institution; that is, to make it of all the help possible to all the people possible in every way possible.

Hoping to hear from you again at your earliest convenience, I am,

Very sincerely yours, L. B. McBrayer,
Superintendent.

Chapel Hill, N. C., April 18, 1916.

Dr. L. B. McBrayer, *Superintendent,*
N. C. Sanatorium for the Treatment of Tuberculosis,
Sanatorium, N. C.

Dear Dr. McBrayer:—Your letter of April 18th to Dr. Joseph Hyde Pratt has been received in his absence from the office and, as you ask for an immediate answer, I am writing for him.

Dr. Pratt did not think it necessary to have a formal agreement made out and signed by the contracting parties in the arrangement for utilizing part of the Sanatorium property for forestry experiments. He thought it sufficient to get the formal assent of yourself and the State Board of Health to the arrangement, and to have the consent of the State Board recorded in the minutes of the Board and the action formally communicated to him by you in a letter. As there is a considerable possibility of the management, both of the State Board of Health and of the State Geological Board, changing considerably in twenty-five years, it seems advisable to have the arrangement recorded in some definite way. I think, however, that the plan outlined above will answer for the purpose, as undoubtedly the transaction will be printed in the State Geologist's Biennial Report, and probably also in the Report of the State Board of Health or your own report.

I am very glad to know that the arrangement proposed meets with your approval; I trust, also, that the State Board will approve the plan.

I thank you for your letter to me of April 18th, and I shall be glad to hear from you as to the further development of plans.

With kind regards.

Very sincerely yours, J. S. Holmes,
State Forester.

SANATORIUM, N. C., April 24, 1916.

DR. JOSEPH HYDE PRATT,
State Geologist,
Chapel Hill, N. C.

MY DEAR DOCTOR:—The matter we have had under consideration, to wit, the turning over to your department 300 acres of land on our northern border for reforestation of long-leaf pine, was brought to the attention of the State Board of Health Friday. They were very much pleased to have you take up this work, and by unanimous vote authorized me to say to you that you are at liberty to go ahead with the work in accordance with our correspondence.

With assurances of esteem, I am,

Most sincerely yours, L. B. MCBRAYER,
Superintendent.

CHAPEL HILL, N. C., April 28, 1916.

DR. L. B. MCBRAYER,
Sanatorium, N. C.

MY DEAR DR. MCBRAYER:—I wish to acknowledge receipt of yours of April 24th in regard to our department taking over 300 acres of land belonging to the Sanatorium. Just as soon as possible we will arrange to plan out the work that we will want to do in connection with this land, and also take up with you anything that you wish to do in connection with the balance of the land. I want to make this work just as beneficial as I can to the Sanatorium property, as any good results that we obtain are of benefit to the State.

With best wishes.

Yours sincerely, JOSEPH HYDE PRATT,
State Geologist.

One week in November (12-18) was spent by the Forester at Sanatorium, Hoke County, N. C., assisting in the survey of the State property on which is situated the Sanatorium for the Treatment of Tuberculosis. A part of this property, lying on the northwest side of it and amounting to some 300 acres, was tentatively laid off as a State Experiment Forest in accordance with the agreement entered into last spring. On a part of this area a small amount of seed of loblolly and maritime pine was sown. Later in the month, after receiving seed of two other species—longleaf pine and slash pine—a second trip was made to Sanatorium and these were sown.

CHESTNUT BLIGHT

The appropriation in the United States Agricultural Bill for the continuation of the work of the Division of Forest Pathology in connection with the study of chestnut blight was cut out and the bill passed without restoring this item. As a result, this investigation, which had been conducted in this State in coöperation with the State Survey, will have to be discontinued. Early in the spring infected chestnut was dis-

covered both in the Van Lindley Nursery at Pomona and also in the native chestnut around Guilford College. Steps were taken to prevent the spread, and all infection that could be found was thoroughly destroyed and it is hoped that no future infection will take place. Up to the present time there has been no report of infected trees.

ARBOR DAY

Amongst other educational and publicity measures urged by the Survey to better acquaint the people of North Carolina with forest conditions and interest them in the intelligent care of forest and shade trees, the observance of a State Arbor Day has been especially stressed. Following the passage of the law (Chap. 51, Laws of 1915) for the establishment of an Arbor Day, the Survey, at the request of the State Superintendent of Public Instruction, prepared an Arbor and Bird Day Manual for the use of the Public Schools. This was published and distributed by the Department of Education. A second Arbor and Bird Day Manual was, with the coöperation of the State Federation of Women's Clubs, prepared by the State Forester in 1916, and this was published in the same way. Special addresses to school children have been given by both the State Geologist and the Forester, on Arbor Day as well as at other times.

NORTH CAROLINA FORESTRY ASSOCIATION

The Survey has materially assisted the North Carolina Forestry Association in its activities, especially in holding its semi-annual meetings, which have attracted favorable attention far beyond our own borders. The summer meeting of 1916, largely through the efforts of the Survey and the interested coöperation of kindred organizations, was expanded into the Southern Forestry Congress, which resulted in a meeting of nation-wide importance and interest.

Resolutions adopted by this Association at its various meetings, relating to State forestry problems are as follows:

RESOLUTIONS ADOPTED BY THE NORTH CAROLINA FORESTRY ASSOCIATION IN THEIR ANNUAL CONVENTION.

Raleigh, N. C., January 13, 1915.

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1. Mount Mitchell for a State Park

Whereas, The spruce forests on the slopes of Mount Mitchell and near-by peaks are being devastated by destructive lumbering followed by fires, and

Whereas, It is generally agreed that the value of these mountains to the people of the State for park purposes and for historic and sentimental interest warrants the acquirement by the State as a public park and State forest, an area including the summit of Mount Mitchell; therefore be it

Resolved, That we, the North Carolina Forestry Association in annual session assembled do hereby respectfully urge the General Assembly to take some definite action for the preservation of the forests on the summit and slopes of Mount Mitchell.

2. Fire Protective Legislation

Whereas, The forests of North Carolina are absolutely necessary to the well-being of all our principal industries and to the future welfare of the State, and

Whereas, The annual damage to these forests from fires amounts to the enormous sum of $650,000, and

Whereas, A large part of this fire damage could be prevented by a State fire protective system; therefore be it

Resolved, That the General Assembly now in session be urged and requested to pass adequate legislation looking to the establishment of a State fire protective system.

3. Federal Cooperation

Resolved, That we hereby express our appreciation to the United States Department of Agriculture for their offer to coöperate with the State of North Carolina in forest fire prevention, and

Resolved further, That our Senators and Representatives in Congress be and are hereby urged to secure the renewal of the appropriation for the Weeks Law from which this coöperative fund is promised.

4. Local Forestry Clubs

Resolved, That the North Carolina Forestry Association encourage the organization of local Forestry Clubs, in each county in the State, and that such clubs be urged to organize their own system of fire protection.

5. Forestry in the Schools

Resolved, That the North Carolina Forestry Association urge upon the public school authorities of the State, the desirability of including in their curriculum some study of forestry, and

Resolved further, That the observance of Arbor Day by every public school in North Carolina be urged.

6. Stock Law

Whereas, The destruction of the young growth and reproduction by live stock, and by fires set by owners of live stock running at large is still enormous in this State;

Resolved, That the General Assembly be respectfully urged to extend the Stock Law in North Carolina by passing a State-wide Stock Law.

7. Thanks of the Association

Resolved, That the thanks of this Association be extended to the State House of Representatives, the Raleigh Chamber of Commerce, the City of Raleigh, the Raleigh *News and Observer,* and the *Raleigh Times* for the courtesies shown us in connection with this convention.

RESOLUTIONS ADOPTED BY THE NORTH CAROLINA FORESTRY ASSOCIATION IN THEIR ANNUAL CONVENTION.

New Bern, N. C., January 25-26, 1916

1. Weeks Law Purchase

Whereas, The Weeks Law for the protection of the headwaters of navigable streams has resulted in the purchase by the Federal Government of approximately 270,000 acres of forest land in Western North Carolina, and

Whereas, The tenure and administration of this land is calculated to result in much permanent benefit to this State and to the whole country, and

Whereas, A continuance of the policy of land purchase, at least for a period of five years more, is essential to the greatest success of this policy; therefore, be it

Resolved, That we earnestly urge the continuance of the annual appropriation of $2,000,000 for the purchase of lands for the Appalachian National Forests, and respectfully request the North Carolina delegation in Congress to unitedly support any proper measure having this end in view.

Resolved further, That we hereby approve the action of the American Forestry Association in urging the passage of this measure, and agree to pay twenty-five dollars ($25.00) or as much of it as may be found necessary, towards the expenses of their special agent employed for this purpose.

2. Federal Assistance in Fire Protection

Whereas, The Federal Government last year granted us an allotment of not to exceed $2,000 under the Weeks Law, for the employment of patrolmen and lookouts to help protect from fire the forested watersheds of navigable streams, and

Whereas, We have already obtained gratifying results in organizing coöperative forest fire protection and in stimulating the desire to prevent fires in North Carolina by reasons of this assistance; therefore, be it

Resolved, That we, the North Carolina Forestry Association in Annual Convention, do earnestly request that the appropriation for this purpose be considered an experiment no longer and that it be made a continual annual appropriation.

3. White Pine Blister Rust

Resolved, That the present Congress be requested to make a special appropriation to be used by the United States Forest Service in coöperative work with the different States, to combat the spread of the Chestnut Blight and the White Pine Blister Rust and, if possible, keep these diseases from spreading further in our forests. And that a copy of this resolution be sent to each of our National Representatives and Senators, with the request that they use their influence to this end.

4. Game Refuges

Whereas, There has been and is now no provision for setting aside National Forests in this State as Park areas, and

Whereas, There are no adequate laws for the protection of birds, game, and wild animals inhabiting these areas, and

Whereas, The Honorable John H. Small has seen fit to introduce in our National Congress a bill creating game refuges of said areas, and providing for the protection and conservation of birds, game, and wild animals inhabiting said areas; therefore, be it

Resolved, That the North Carolina Forestry Association extend its thanks to the Honorable John H. Small, for introducing said bill, and for all his efforts in behalf of conservation, and pledge him their support in obtaining this and all similar legislation.

5. Arbor Day Manual

Whereas, We believe that our birds and our forests are so closely related as to be interdependent, and

Whereas, There are no formal courses of bird study in our schools, and

Whereas, The State Department of Education saw fit last year to issue and distribute to the schools of the State an Arbor and Bird Day Manual, and

Whereas, We believe such a Manual to be of very great benefit to our educational system and to the cause of conservation, therefore, be it

Resolved, That the members of the North Carolina Forestry Association extend their thanks to our State Department of Education for issuing and distributing said Arbor and Bird Day Manual and respectfully suggest that the Department continue to issue such a Manual annually and that it be as comprehensive as possible; distributed to the schools as early as practicable; and its observance made as universal as conditions will allow.

6. Stock Law

Whereas, The North Carolina Forestry Association recognizes the absolute necessity of the protection of the young growth in the forests, and the grave, ever present, and increasing danger arising from the lack of a state-wide no fence law; therefore, be it

Resolved, That the North Carolina Forestry Association, in annual convention assembled, do hereby declare it the duty of all good citizens to assist in the conservation of the resources of the State and to that end urge the public, the press, and the officials of the State to lend their aid toward the spread of public sentiment to assist the work of extending the no-fence law over the entire State.

7. Death of Mr. B. E. Rice

Whereas, In the dispensation of Divine Providence Mr. B. E. Rice has been removed from our midst, and

Whereas, He was a constant and interested attendant at nearly all our conventions and has assisted us by wise suggestions and by strong advocacy of forestry practice, and

Whereas, His cheering and encouraging words and his bright and friendly personality will be greatly missed by us; therefore, be it

Resolved, That the North Carolina Forestry Association, in annual convention assembled, do hereby tender to the widow and family of Mr. B. E. Rice their sincere sympathy for the great loss they have met in the death of our friend, whose attendance was our inspiration and whose absence we shall always deplore.

8. Officers

Resolved, That the North Carolina Forestry Association, desiring to record their appreciation of the earnest, faithful, and zealous service

of the officers of the Association, do hereby tender their thanks for their labors during the past year.

9. The Forester

Resolved, That the thanks of the North Carolina Forestry Association be tendered to Mr. Graves, the Forester of the United States, for his courtesy in sending a representative of the Forest Service, and to Mr. W. W. Ashe for the able and instructive address which he delivered.

10. Entertainment

Resolved, That the thanks of the Association be tendered to the New Bern Chamber of Commerce and the Woman's Club for their preparation for the convention and the entertainment provided by them; to the local lumbermen for the trip to the woods and over the sawmill, to the good people of New Bern for their interest in our Association and its work; and to the local press for their coöperation in advertising and reporting our meeting.

REPORT OF SPECIAL COMMITTEE APPOINTED TO DRAFT RESOLUTIONS REGARDING THE DEATH OF DR. J. A. HOLMES

Whereas, Joseph Austin Holmes was the first to take up the investigation of the forestry problems of North Carolina, and started the campaign of education looking toward the preservation and conservation of our forest areas by beginning the investigations as to the causes and extent of damage caused by forest fires; the increased floods due to deforested areas; the conservation of our turpentine industry by experimental work in regard to the cup and gutter method now in use in the turpentine industry; the investigations and practical demonstration of the feasibility and practicability of reproducing the longleaf pine; the preparation of reports on the timber trees and timber resources of North Carolina; and the collecting and compiling of information and data regarding flood damage in the Southern Appalachian region, which showed the need of Government aid in forest preservation and led finally to the passage of the Weeks Bill by Congress:

And, whereas, he has been called from his earthly work when he was becoming one of the most powerful forces in this country in regard to the preservation of life and the conservation of our natural resources; therefore, be it

Resolved, by this Association in Convention assembled at New Bern, North Carolina, this twenty-fifth day of January, 1916, that it extend

to the bereaved family of Dr. Holmes its sincerest sympathy at his death, and express to them its fullest appreciation of his value, not only to North Carolina, but to the nation.

And be it further resolved, that this Association extend to the Joseph Austin Holmes "Safety First" Association its interest and approval of the action taken by said Association in regard to preparing a memorial to Dr. Holmes, and that this Association will lend its aid to the endowment of such memorial.

That a copy of these resolutions be sent to the bereaved family and to the State papers.

James H. Gibboney,
Joseph Hyde Pratt,
R. R. Cotten,
Special Committee.

SOUTHERN FORESTRY CONGRESS

Because of the common interest which the states comprising the Southern Appalachian region have in the conservation of their forests and timber supply, and the public interest now being taken in this general region through Federal enactment, it was felt that a meeting which would bring together representatives from these various states for discussing the many problems in this connection would be most timely. Therefore, the North Carolina Geological and Economic Survey, coöperating with the North Carolina Forestry Association, the Association of Eastern Foresters, the American Forestry Association, the Society of American Foresters, the North Carolina Pine Association and the Appalachian Park Association, called the Southern Forestry Congress, which was held at the Battery Park Hotel, Asheville, N. C., July 11-15, 1916. About one hundred and fifty delegates registered, four-fifths of whom came from outside of Asheville. Twenty states were represented by delegates, although there were three Southern States which had no representatives. Upon motion, the Congress was made a permanent organization, and the State Geologist of North Carolina was elected president, and Mr. J. S. Holmes, State Forester, secretary. The proceedings of this Congress will be published and distributed by the Congress.

The program as given below was carried out almost in its entirety, and will give some idea of the many questions and problems which were discussed:

PROGRAM

SOUTHERN FORESTRY CONGRESS

ASHEVILLE, N. C., JULY 11-15, 1916

TUESDAY, JULY 11

Forestry and the Public

MORNING SESSION, 10 O'CLOCK

Invocation.....Bishop Junius C. Horner of Asheville
Address of Welcome.....Governor Locke Craig of North Carolina
Welcome to Asheville.....Hon. J. E. Rankin, Mayor of Asheville
Response from the North,
Dr. Hugh P. Baker, Dean, New York State College of Forestry
Response from the South.....John L. Kaul, Birmingham, Alabama
Appointment of Committees:
Resolutions Committee
Registration Committee
Publicity Committee
Committee on Permanent Organization

ADDRESSES*

The Southern Forests and Their Place In the Nation's Timber Supply—Hon. H. S. Graves, Chief U. S. Forester.
The Forests in Relation to the Upbuilding of the South—Dr. Clarence J. Owens, Secretary, Southern Commercial Congress, Washington, D. C.
Reëstablishment and Protection of Big Game In the Southern Appalachians—Mr. Edmund Seymour, President, American Bison Society, New York.
Biltmore Forest and Forest Plantations—Verne Rhoades, Forest Supervisor, Pisgah National Forest.

AFTERNOON SESSION, 2:30 O'CLOCK

ADDRESSES

Greetings from the American Forestry Association—Hon. Charles Lathrop Pack, President, American Forestry Association, Lakewood, New Jersey.
The Part of the Women's Clubs in Forest Conservation—Mrs. T. W. Lingle, President, North Carolina Federation of Women's Clubs.
A Practical Example of Forest Management in Southern Yellow Pine—Mr. Henry E. Hardtner, President, Urania Lumber Company, Urania, La.
The Erosion Problem of the South and Its Relation to Forestry—Mr. R. S. Maddox, Forester, Tennessee Geological Survey, Nashville, Tenn.

TUESDAY EVENING, 9 O'CLOCK

Informal Reception to Visiting Delegates by the Women's Clubs of Asheville at the Battery Park Hotel.

*Fifteen minutes will be allowed for discussion after each address.

WEDNESDAY, JULY 12

Inspection of Biltmore Forest Plantations.—Carriages will leave the hotel at 9:30 a. m., drive through the celebrated Biltmore estate, visiting four or five plantations before noon. A light lunch will be tendered by the Biltmore Estate at the dairy at 12:30. After lunch several more plantations and perhaps some of the old cuttings may be visited, or other points of interest may be seen.

WEDNESDAY EVENING, 7:30 O'CLOCK

Informal Get-together Dinner for Delegates at Battery Park Hotel.

THURSDAY, JULY 13

MORNING SESSION, 10 O'CLOCK

Forest Fire Protection

ADDRESSES

Organization of State Protective Systems—Prof. H. H. Chapman, Yale Forest School.

What the States Can Do In Forest Fire Protection—F. W. Besley, State Forester of Maryland.

Publicity and Education in Forest Protection in the South—J. E. Barton, State Forester of Kentucky.

Protection of Federal Forest Lands in the South—Wm. L. Hall, District Forester in Charge of the Eastern National Forests.

What West Virginia Is Doing In Forest Fire Protection—Hon. J. A. Viquesney, Forest, Game, and Fish Warden of West Virginia.

AFTERNOON SESSION, 2:30 O'CLOCK

Southern Forestry Practice

ADDRESSES

Southern Pineries, Their Possibilities and Future—Prof. Ralph H. Bryant, Yale University.

Forest Reproduction—E. H. Frothingham, Forest Examiner.

The Regeneration of the Southern Pine Forests—Prof. J. W. Toumey, Director, Yale Forest School.

The Naval Stores Industry: How It Can be Perpetuated In the South—I. F. Eldredge, Supervisor, Florida National Forest.

The Forests of the Future: Second Growth—W. W. Ashe, U. S. Forest Service.

EVENING SESSION, 7:30 O'CLOCK

Separate conferences or executive meetings of the Southern Weeks Law Collaborators, the Southern Foresters, the Association of Eastern Foresters, and other organizations taking active part in the Congress.

FRIDAY, JULY 14

All-day automobile trip through Pisgah National Forest.

Field meetings of Society of American Foresters and Association of Eastern Foresters will be held in the Pink Beds in Pisgah Forest. Program for these

meetings will be in charge of Messrs. Wm. L. Hall, of the Society of American Foresters, and Alfred Gaskill, Secretary, Association of Eastern Foresters. Detailed information in regard to the trip will be announced the previous day.

SATURDAY, JULY 15

Trip over logging railroad to Mount Mitchell State Park.

Train leaves Asheville station 8:50 a. m., and arrives at Mount Mitchell station at 9:30. Change to Mt. Mitchell Railroad, which goes within one and one-half miles of the summit. Return in time to take the 7:20 train to Asheville. Total railroad fare about $3.25.

(If preferred, this trip may be made on either Monday, Wednesday, or Friday.)

Follow-up conferences of landowners, lumbermen, foresters, Forest Fire Protective Associations, etc., may be held.

Forest Moving Pictures.—Motion pictures dealing with forestry subjects will, through the cordial coöperation of the S. A. Lynch Enterprises, be given at the Majestic, Galax, and Princess theaters throughout the week. Accredited delegates to the Congress will be furnished free tickets to see these pictures.

The following films will be shown:

A. One film loaned by the Milwaukee Journal, Milwaukee, Wis.

1. "Use of Aeroplanes in Detecting Forest Fires." The picture shows the hydroaeroplane leaving for scout duty, our camera man being a passenger, which afforded a great opportunity for panoramic views of the forest, and winds up with the discovery of a forest fire. The crew in the hydroaeroplane sounds the alarm, which is responded to by the crew, who successfully put out the fire.

The machine used is owned by Mr. L. A. Vilas, who offered his services to the forestry branch free of charge last year for the purpose of experimenting in the detection of fires.

The machine weighs 1,400 pounds, can rise to the height of 2,000 feet in six minutes, is equipped with a 100 horsepower engine, travels at the rate of sixty miles per hour in the air, and consumes about eight gallons of gasoline per hour. A fire thirty or forty miles away can easily be detected.

B. Four films loaned by the U. S. Forest Service, "The National Forests of the West."

2. "What a Careless Hunter Can Do." This shows a fire on the Shasta National Forest, California, started by a hunter carelessly throwing aside a burning match, and culminating in the burning of the town of Sisson. The Forest Service methods of fire discovery and fire-fighting are graphically shown.

3. "Live-stock Grazing on the National Forests." This film portrays cattle grazing in the Southwest, the branding of cattle, a round-up, sheep grazing, the counting of sheep as they enter a forest, sheep on their way to the summer ranges, the bedding of sheep, goat grazing on a National Forest in New Mexico, and shipping sheep to market.

4. "Work of a Forest Ranger." This film shows many sidelights of the forest ranger's work, presented as an average day in his life.

5. "Recreation and Water Protection on the National Forests." Camping, fishing, traveling, and summer homes on National Forests are shown. The

second portion of this film is of the Bull Run watershed and the water supply of the city of Portland, Oregon.

C. Two films loaned by the New York State College of Forestry, Syracuse, New York.

6. Five hundred feet under title of "Many Schools in the State of New York celebrate Arbor and Forest Day by planting from 1,000 to 5,000 trees on public property under direction of a forester from the State College of Forestry at Syracuse."

This film takes up the students going into the firehouse for the purpose of securing tools to plant these trees, then a few feet of the journey to the watershed; a group of some fifty or sixty students actually engaged in planting trees under the direction of the college forester; a luncheon scene showing bread line formed and the children eating on the grass afterward; a few feet of film of one of the oldest citizens of the town planting a forest tree; also about thirty feet showing the ladies of the Woman's Club planting trees and about thirty feet of the Camp Fire Girls, and then, lastly, the entire party homeward bound.

7. The other five hundred feet of film shows a party of our students engaged in the reforestation of idle land in the northern part of the State of New York on property belonging to the New York Central. This picture shows the boys in camp; going to and from New York; actually planting trees; and recreation of the boys.

D. Two films loaned by the State Forester, Boston, Mass.

8. "Reforestation."
9. "Forest Fires."

E. One film loaned by the Minnesota Forest Service, St. Paul, Minnesota.

10. "Northern Minnesota Forest Scenes."

F. One film loaned by the New York State Conservation Commission, Albany, N. Y.

11. "The Match in the Forest." This film, produced under the direction of Commissioner Pratt, contrasts the result of a careful hunter who extinguishes his match and that of another who carelessly drops one into the dry tinder of the forest floor. A conflagration results, which is discovered by an observer on his mountain station. The alarm is sent by telephone to the district ranger, who hurries his fire-fighters to the scene by automobile and forest trail. The flames are extinguished, amid much smoke, by the use of axes, shovels, and hoes, rather than the water of the city fire departments.

G. Five reels loaned by the Southern Pine Association, New Orleans, La.

12-16. "Methods of Logging in Southern Pine Forests."

The resolutions which were passed by the Southern Forestry Congress, in the order in which they were presented, are given as follows:

THE GEORGE W. VANDERBILT MEMORIAL IN THE PISGAH NATIONAL FOREST

On July 12th, at the first session of the Southern Forestry Congress, held at Battery Park Hotel, Asheville, N. C., Mr. George S. Powell,

Secretary, Appalachian Park Association, presented the following letter and resolution for the consideration of the Congress:

IMPORTANT

THE AMERICAN SCENIC AND HISTORIC PRESERVATION SOCIETY

401 FIFTH AVENUE, NEW YORK CITY, July 10, 1916.

GEORGE S. POWELL, ESQ., *Secretary,*
Appalachian Park Association,
Asheville, N. C.

DEAR SIR:—When we stop to realize that the great Pisgah National Forest—that great mountain preserve in Asheville—was due to the instrumentality, foresight, and generosity of the late George W. Vanderbilt, it seems to me that the park should be named "Vanderbilt Park" or "Pisgah National Forest—Founded by George W. Vanderbilt."

But as this has not been done, I shall be glad to subscribe the initial $10 toward a fund for establishing a tablet in the park or at one of the prominent entrances. After a conference with my esteemed friend, Hon. Gifford Pinchot, I am able to say that he will also contribute a like amount toward such a fund.

If you will present this matter at the Southern Forestry Congress, a sufficient sum can be raised at once to do something in this direction. I will remit the moment I hear that your organization is willing to act.

Believe me, Very truly yours,

Why not start the fund now? GEORGE F. KUNZ, *President.*

Resolved, That this meeting endorse the idea of erecting a tablet at the entrance to Pisgah National Forest for the purpose of reciting and commemorating the historical facts in connection with the development of this forest by Mr. George W. Vanderbilt, under a system of scientific forestry, and the taking over of this forest by the National Government; and be it further

Resolved, That the President of the Southern Forestry Congress appoint a committee of seven with authority to raise necessary funds and erect said tablet.

The resolution was presented in a strong speech by Mr. Powell, and was seconded in an equally forceful speech by Mr. Charles Lathrop Pack. It was unanimously adopted.

In accordance with this resolution, Dr. Joseph Hyde Pratt, President of the Southern Forestry Congress, appointed the following committee:

Governor Locke Craig of North Carolina, Chairman.

Dr. Joseph Hyde Pratt, State Geologist of North Carolina, Chapel Hill, N. C.

Dr. W. H. Holmes, Smithsonian Institute, Washington, D. C.

Charles Lathrop Pack, President, American Forestry Association, Lakewood, New Jersey.

Henry S. Graves, Forester, U. S. Forest Service, Washington, D. C.

George F. Kunz, President, American Scenic and Historic Preservation Society, 401 Fifth Ave., New York City.

George S. Powell, Secretary, Appalachian Park Association, Asheville, N. C.

The following resolution was introduced by Mr. George S. Powell, Secretary, Appalachian Park Association, at the afternoon session, July 11.

Whereas an amendment to the Agricultural Appropriation Bill has recently been approved in the Senate, appropriating $3,000,000 for the purpose of continuing the purchase of forest areas under the Weeks Law, and whereas the continuance of these purchases is of very great importance to the public welfare of the Eastern part of the United States; therefore be it

Resolved, That the Southern Forestry Congress, composed of delegates from practically all the Eastern States, earnestly urge the enactment of this measure into law.

The resolution was unanimously adopted.

A motion was made that the president be instructed to send telegrams to the President of the United States and to the following members of the House of Representatives: Hon. Champ Clark, Speaker of the House of Representatives; Hon. Claude Kitchen, Chairman of the Ways and Means Committee; Hon. John J. Fitzgerald, Chairman of the Appropriations Committee; and Hon. Asbury F. Lever, Chairman of the Committee on Agriculture.

The motion was unanimously carried.

GENERAL RESOLUTIONS

ADOPTED BY THE

SOUTHERN FORESTRY CONGRESS

HELD AT ASHEVILLE, N. C., JULY 11-16, 1916

1. WHITE PINE BLISTER RUST

Whereas the imported fungus disease known as the White Pine Blister Rust, which has rendered the culture of American white pines impracticable in many parts of Europe, has already been found in nine States of the Union, and probably exists in other States; and

Whereas this disease is a national menace, not only to all the white pine forests of the East but also to the white pine and sugar pine forests of the West, therefore be it

Resolved, That immediate, drastic action is necessary if a national calamity is to be averted, and to this end the Southern Forestry Congress strongly urges appropriations by the National Government and by all States in which imported five-leaved pines have been planted, adequate to locate and eradicate all infections, and further recommends that sufficient power be conferred on the officials charged with this work to make eradication effective.

2. GAME REFUGES

Whereas the acquisition of lands by the Federal Government for the Appalachian National Forests affords an unusual opportunity for restoration and conservation of game, and

Whereas there are pending before the Congress of the United States certain measures authorizing the establishment of game refuges on the National Forests under the Chamberlain-Hayden Game Sanctuary Bill (S. 6881, H. R. 11712), and the protection of game on the Appalachian National Forests under the Senate amendment to the Agricultural Appropriation Bill, therefore be it

Resolved, That the Southern Forestry Congress heartily endorses and recommends the passage of said measures, and in the event of their enactment into law, urges active and cordial coöperation of State officials and local associations with the Federal authorities in the establishment of such refuges. in the introduction of big game in suitable localities, and in enlisting public sentiment in favor of game conservation on such forests.

3. Separate State Forestry and Game Organizations

Whereas it has been shown by experience that the combination of the State Forestry organization with the State fish and game organization operates disadvantageously to both, and tends to reduce the efficiency of both through the division of interest and the diversion of appropriations from the purposes for which they were intended, and

Whereas a combination of the functions of the forest officers with those of the fish and game officers is especially detrimental to the development of a spirit of hearty coöperation on the part of the general public in the suppression of forest fires, therefore be it

Resolved, That the Southern Forestry Congress endorses the policy of separate State Forestry departments, but recommends close coöperation between the State departments of forestry and of fish and game.

4. Federal Aid in Fire Protection

Whereas the excellent progress made in fire protection under the Weeks Law in States which have come under its operation has fully demonstrated the desirability of this manner of coöperation between the Nation and the States, therefore be it

Resolved, That the Southern Forestry Congress urges the continuation of these appropriations by the National Congress, and urges the States which are not now qualified under the law to receive the Federal assistance to take the action necessary to avail themselves of the Government's coöperation.

5. Forest Protective Associations

Whereas the control of forest fires is the greatest factor in forest conservation, and

Whereas effective control demands affirmative action on the part of not only the public agencies but private interests as well, and hearty coöperation between them, therefore be it

Resolved, That the Southern Forestry Congress urges private owners of timberlands in each of the Southern States to form organizations for fire protective purposes, by means of which the coöperation between all agencies, both public and private, can be made effective.

6. Adequate Appropriations for Forestry

Whereas progress in State Forestry requires not only an effective non-political organization at its head, but also sufficient funds to carry on the

important work of popular education in forestry, establishment of organized fire protection, assistance to woodland owners in the management of their property, checking erosion, and supervision of such State Forests as may be established, and

Whereas many Southern States, which have already made an excellent beginning by the establishment of forestry departments, are as yet without adequate financial support, therefore be it

Resolved, That the Southern Forestry Congress urges upon the legislatures of the respective States a more liberal policy in providing funds for the conduct of forestry work, and in passing such additional legislation as may be necessary to make this work effective in practice.

7. Recent Louisiana Law Approved

Whereas the recent act passed by the Legislature of Louisiana which provides that the State forestry work be in charge of a trained forester, and that the expenditures for forestry shall equal 20 per cent of the revenue derived from the products tax on timber and turpentine, marks a great forward step in forest conservation, therefore be it

Resolved, That the Southern Forestry Congress heartily endorses this action of Louisiana.

8. Urge Forestry Laws and Funds

Whereas the States of South Carolina, Georgia, Florida, Mississippi, and Arkansas are now without State forest organization and entirely without appropriations for State forestry work, therefore be it

Resolved, That the Southern Forestry Congress urges upon the legislatures of the above States the serious consideration of laws and funds to improve their present forest conditions.

9. Biltmore Estate

Resolved, That the Southern Forestry Congress does hereby express its hearty thanks to Mrs. George W. Vanderbilt, Mr. C. D. Beadle, Dr. and Mrs. A. S. Wheeler, and Mr. C. T. Rankin, for making possible the interesting visit to the Biltmore estate, and for their courteous and greatly appreciated entertainment, and to Mr. Verne Rhoades for the preparation of the valuable booklet on the Biltmore plantations.

10. Women's Clubs

Resolved, That the Southern Forestry Congress, recognizing and heartily commending the very valuable work done for the spread of the movement for the protection and perpetuation of our Southern forests by the General and State Federations of Women's Clubs and the individual clubs and club women of the South, does hereby urge these good and patriotic women to continue and increase their efforts and coöperate as closely as possible with all other organizations with this end in view.

11. Appreciation and Thanks

Resolved, That the Southern Forestry Congress hereby expresses its appreciation and tenders its thanks to the Governor of North Carolina, to the Mayor and Board of Trade of Asheville, to the S. A. Lynch Enterprises, to the

local press and Women's Clubs, and to the management and staff of Battery Park Hotel for the many courtesies extended to the Congress and its delegates during their most pleasant stay in Asheville.

FORESTRY LECTURES

There is no question but what the lectures and addresses that have been given from time to time throughout the State, partly in connection with Farmers' Institutes and otherwise, have been of very great value to the forestry work in North Carolina. The attention of the people has been called to the value of our forests, the need for their conservation and protection, the value of the farm woodlot and its care, etc. During the past two years the State Geologist and Forester have made the following addresses:

Forestry Addresses by the State Geologist

January 13, 1915, at Raleigh, N. C., on *Forestry Legislation for North Carolina.*

March 2, 3, 4, 1915, at West Raleigh, N. C., Chapel talks before students of A. and M. College on *Conservation and Utilization of Our Natural Resources.*

May 5, 1915, at Goldsboro, N. C., before the North Carolina Federation of Women's Clubs, on *Conservation.*

July 7, 1915, at Montreat, N. C., before Conference of Coöperative Forest Fire Protection of North Carolina Forestry Association, on *Conservation of Forests.*

November 5, 1915, at Charlotte, N. C., illustrated lecture before Civics Department of Woman's Club.

January 25, 1916, at New Bern, N. C., before North Carolina Forestry Convention, on *Forest Conservation in North Carolina.*

January 28, 1916, at Washington, D. C., before Agricultural Committee of House of Representatives, on *Need of Appalachian Forest Reserves.*

February 28, 1916, at Raleigh, N. C., before Fortnightly Club, on *Forests and Trees.*

July 11, 1916, at Asheville, N. C., short talk before Southern Forestry Congress.

Addresses by the Forester at Farmers' Institutes

Place	County	Date	Subject of Address
Kennedy Schoolhouse	Davidson	July 27, 1915	Improving the Woodlot.
Reid's Cross Roads	Davidson	July 28, 1915	Forest Protection.
Norwood	Stanly	July 29, 1915	The Place of the Woodlot on the Farm, Planting Trees Around the Schoolhouse.
Harmony	Iredell	July 30, 1915	The Woodlot and Its Value.
Iredell Test Farm	Iredell	July 31, 1915	The Woodlot and Soil Improvement. Planting Shade Trees.
Taylorsville	Alexander	Aug. 2, 1915	Care of the Woodlot.
Mount Pleasant	Cabarrus	Aug. 3, 1915	Care of the Woodlot. Tree Planting and Bird Preservation.
Foard's Store	Catawba	Aug. 4, 1915	Improving the Woodlot.
Granite Falls	Caldwell	Aug. 5, 1915	Protection of Woodlands from Fire.

Place	County	Date	Subject of Address
Oak Hill	Caldwell	Aug. 6, 1915	Improving the Woodlot and Protecting it from Fire.
Patterson's School	Caldwell	Aug. 7, 1915	A Plan of Fire Protection.
Yadkinville	Yadkin	Aug. 9, 1915	Erosion and Woodlot Protection. Arbor Day and Tree Planting.
Clemmons	Forsyth	Aug. 10, 1915	The Woodlot, Its Uses and Care.
Burke's Grove	Forsyth	Aug. 11, 1915	Use and Care of the Woodlot.
Dillard	Stokes	Aug. 12, 1915	Farm Woodlands and Erosion. Arbor Day and Planting Shade Trees.
Belews Creek	Forsyth	Aug. 13, 1915	Woodlot and Farm Management. Shade Tree Planting and Arbor Day.
Piney Grove	Surry	Aug. 14, 1915	Woodlot Forestry and Forest Protection. Planting Trees Around the School and Home.
Antioch Church	Surry	Aug. 16, 1915	Improving the Farm Woodlot. Tree Planting and Forestry.
Pilot Mountain	Surry	Aug. 17, 1915	Improving the Woodlot and Planting Old Fields. Planting Shade and Ornamental Trees.
Woodleaf	Rowan	Aug. 18, 1915	Forest Fires. Improving the Woodlot. Planting Locust. Arbor Day and Tree Planting.

Special Addresses by the Forester

December 3, 1914, at Greensboro, N. C., before students of the Colored A. and M. College, on *Our Forests and Forestry* (illustrated).

January 13, 1915, at Raleigh, N. C., talk before the North Carolina Forestry Association.

February 3, 1915, at New Bern, N. C., at Farm Demonstrators' Meeting, on *Forestry for Farmers and How to Reach Them.*

February 4, 1915, at Vanceboro, N. C., on *Forest Protection and Forest Improvement.*

February 6, 1915, at Trent Schoolhouse, Pamlico County, N. C., on *Improving Farm Woodlands.*

February 9, 1915, at Henderson, N. C., before Farm Demonstrators, on *Farm Forestry.*

March 3, 1915, at Henderson, N. C., before a meeting of Farm Demonstration Agents, on *Forestry for Farmers.*

March 25, 1915, at Norfolk, Va., before the North Carolina Pine Association, on *North Carolina Forestry Association: Its Work and Needs.*

March 30, 1915, at Chapel Hill, N. C., before the public school, on *Forest Utilization and Protection.*

July 7, 1915, at Montreat, N. C., a talk before the North Carolina Forestry Association.

July 19, 1915, at Chapel Hill, N. C., before University Summer School, on *Our Forests, Their Use and Misuse.*

September 8, 1915, at Saluda, N. C., on *Forest Fire Protection.*

November 25, 1915, at Trinity, N. C., on *the Forests of North Carolina, Their Use and Abuse.*

November 26, 1915, at Ashboro, N. C., on *the Forests of North Carolina, Their Use and Abuse.*

November 27, 1915, at Randleman, N. C., on *the Forests of North Carolina, Their Use and Abuse.*

January 3, 1916, at Asheville, N. C., before Appalachian Logging Congress, on *Fire Protective Work.*

January 25, 1916, address before the Forestry Convention.

February 25, 1916, at Linville, N. C., address before Linville Forest Protective Association.

April 11, 1916, at Tarboro, N. C., illustrated lecture on *Forestry.*

April 12, 1916, at Whitakers, N. C., illustrated lecture on *Forestry.*

April 28, 1916, at Asheville, N. C., before Appalachian Logging Congress, on *Coöperative Fire Protection for Our Mining Lands.*

November 3, 1916, at Charlotte, N. C., on Arbor Day, short addresses at each of the ten schools to all the children, on *the Value of Trees and Forests.*

November 10, 1916, at Chapel Hill, N. C., to the school children and visitors, on *Selecting and Planting Shade Trees.*

FLOOD CONDITIONS

As soon as possible after the extraordinary storm of July, 1916, the Survey began, in coöperation with the United States Department of Agriculture, a study of the flooded areas.

Study of the Mountain Floods

Following the disastrous floods of July, 1916, in Western North Carolina, a study of the flooded area was determined upon, with a view of securing historic as well as scientific facts which would be of permanent value to the people of the State. With this end in view a letter was sent to the Secretary of Agriculture, Washington, D. C., on July 26th, inviting his coöperation in a study of the region affected and suggesting that a representative of the United States Bureau of Soils and of the Office of Farm Management coöperate with the Forester of the Survey in such a study.

About the same time (July 25th) and entirely independently, the United States Forester started a somewhat similar investigation by two of his agents already in the mountains of Western North Carolina, and the Forester of the Survey was asked to coöperate in this study. As a result, the State Forester met Mr. E. H. Frothingham, of the United States Forest Service, and Professor L. J. Young, of the University of Michigan, a collaborator in the Forest Service, in Asheville. It was mutually arranged that Prof. Young should visit the Highlands region in Jackson and Macon counties; Mr. Frothingham, the McDowell and, possibly, the east Buncombe areas; and the State Forester, the slopes of the Yadkin and Catawba rivers in Caldwell, and, possibly, Wilkes counties. A week later, August 3, these three met at Marion with Mr.

Raphael Zon, Chief of Forest Investigation, Forest Service; Mr. C. F. Marbut, in charge of the Soil Survey Investigations; and Mr. J. S. Cates, in charge of Farm Organization, of the United States Department of Agriculture. From there the party went to Altapass, where some of the heaviest rainfall was recorded. On returning from there Mr. Cates and Mr. Zon left the party. The two Asheville watersheds were subsequently visited, and then the State Forester accompanied Mr. Marbut to the Johns River region of Caldwell County.

The reports of those who were associated with the Survey in this study have been made to their own departments, and copies of them have not been received by the Survey. The following extracts from the report of the State Forester give a good idea of the results of this study. A number of photographs were secured which will be used in future reports and addresses.

The amount of rainfall was of course the primary factor in the results of the floods. Although the amount which fell at the various stations operated by the United States Weather Bureau is known, yet the fall between these stations can only be approximated. The variation recorded by the observation stations was considerable, and it is probable that as large or larger variations occurred between the stations. It has been thought by the local inhabitants that the variations in rainfall, even over small areas, was so great as to amount to what they call "water spouts" or "cloud bursts." There are, however, no direct and reliable effects to show that any such extreme variations occurred.

From all accounts it would appear, first of all then, that the rainfall was the controlling factor in floods; and, secondly, that this factor was so variable as to greatly complicate the study of the effect of forest cover on rainfall. It must be admitted that forest cover, though undoubtedly affecting to a certain extent the rainfall up to a few inches of rain, had comparatively small effect upon the enormous precipitation of the second storm.

The effect of a perfect forest cover on the watershed is undoubtedly considerable, but its visible effects are greatly reduced both by the excessive rainfall and by the occurrence of slides, which has greatly complicated the problem. There is no doubt a point at which the forest cover ceases to exert a preponderating influence in retarding the rainfall, which it undoubtedly exerts in times of normal rainfall. However, all areas which were covered by an approximately normal forest cover seem to show less damage from floods than those which had been injured by fire and lumbering.

It appears that constantly burning the woods has a more deleterious effect upon flood conditions than lumbering, if the latter is not accompanied by fire. Cut-over areas, owing to the lack of shade, quickly

obtain a dense cover of young growth which greatly helps in preserving the forest floor and retarding rainfall.

It was soon seen that the occurrence of land slides so complicated the flood damage and obliterated in most cases the results which might have shown from the variation in forest cover, that the study resolved itself largely into one of these slides. The photographs taken largely relate to slides and their occurrence, and the principal data recorded is upon this topic.

All things considered, the conclusion must be arrived at that the properly managed and protected forest exercises less influence in controlling such an exceptional fall of water than it does at times of average or flood rainfall.

FORESTRY EXHIBITS

State Fair of 1915.—The space allotted to the Survey for its exhibit being larger than usual, allowed a much more effective display of the forestry exhibit. This consisted of photographs; warning posters, most of which had been collected from the various State Forestry Departments throughout the United States; and samples of North Carolina woods presented by maunfacturers operating in this State. Most of these had been shown before. The forestry publications of the Survey were also shown to advantage.

State Fair of 1916.—The addition of a class of forest products to Department N of the State Fair premium list and the adequate space provided by the management enabled the Survey to considerably increase the size and quality of its exhibit. Owing to lack of publicity, however, few commercial exhibits were made in this Department. There were two collections of pulpwood, one exhibit by the Belhaven Board of Trade, and the second by Mr. W. H. Crocker of Wilmington, who is endeavoring to secure the location of a pulp mill at that place. Copies of letters asking about pulpwood propositions in North Carolina were shown, in order to call attention to the enlarged market for small timber.

Another new feature was the display of four young pine trees of the four different species which are common to the central part of the State. These were labeled so that the school children and others might learn their names.

It had been hoped that school exhibits of forest products competing for prizes offered by the North Carolina Forestry Association, as well as the State Fair, would be shown, but only one, which had been prepared by a pupil in the Hillsboro school, and which was not entered for competition, was displayed.

The Survey collection of woods, photographs, maps, and forest fire posters decorated the walls. Altogether the forestry exhibit of 1916 was the best so far shown.

Local Exhibits.—Material consisting chiefly of photographs, posters, and maps have been loaned and exhibited in connection with the Social Service Congress in Charlotte, January 1916; The North Carolina Forestry Association meeting in New Bern, January 1916; The Wayne County Fair, October 1916; and other smaller occasions.

ADVICE TO LANDOWNERS

A large number of letters from farmers and small landowners have recently been coming into the office, asking for assistance in estimating and marketing their timber such as the Forestry Board of the State of Maryland is giving the farmers in that State. On account of the small appropriation for forestry, it seemed inadvisable, or indeed impossible at this time to change our previous policy of not making purely commercial estimates unless some guarantee was made that forestry practices would be followed. We have therefore been obliged to write them to that effect, giving them only such advice or information as was possible by mail. It seems to me that if the appropriation for the Forestry work of the Survey is increased sufficiently, general woodlot work should be specialized in, and estimates and assistance given on the ground to those who ask it. We could at least spend several days in a county, and in coöperation with the County Farm Demonstration Agent or some other official, visit a number of woodlots and make demonstration cuttings or lectures. I hope this coming year we may be justified in extending this side of the work.

ROAD WORK

One of the objects of the Survey is the investigation of the road problem of the State, and this became one of the most important lines of the Survey work.

The phenomenal growth in the sentiment for good roads in North Carolina during the past score of years has been due largely to the efforts of the North Carolina Geological and Economic Survey, and the various organizations fostered through the work of the survey. This work has of necessity been largely of an educational character through pamphlets published and distributed by the Survey; through press articles prepared by members of the Survey staff; through circulars distributed broadcast over the State; through lectures and addresses by the State Geologist and his assistants in practically every county and most of the townships of the State; through State conventions held annually and sometimes oftener; through exhibits of road pictures, road materials, road models, etc., at the State Fair and at local County Fairs; and, in short, through every avenue for the dissemination of informa-

tion in regard to the value of good roads and best methods of road building.

During the past two years (1915-16) the Survey has worked along the following lines with reference to the road work of the State:

It has completed the work on the Hickory Nut Gap road (part of Asheville-Charlotte Highway) as authorized by the Legislature of 1913. This work required a longer time than was at first expected it would take to complete it because of the fact that all of the money needed for work had to be raised by private subscriptions, collected mostly in Asheville and Buncombe County; and long periods of rain and bad weather limited the time which could be given to actual work. Notwithstanding these conditions, this stretch of road was completed and late in 1915 turned over to the commissioners who had been appointed to take charge of its maintenance in accordance with an act of the General Assembly. It may be stated here, however, that the floods which visited western North Carolina in July, 1916, did great damage to this road; but it is expected that it will be in good shape by the beginning of the tourist season of 1917.

The Survey also continued its general supervision of the Central Highway in Madison County in connection with the special act of the Legislature relating to the working of State's prisoners in that county.

The great object for which the Survey has been working for many years may be said to have been accomplished with the establishment of the State Highway Commission by the Legislature of 1915. It is believed that this is the most valuable and far-reaching road act ever passed by a General Assembly of North Carolina, because it means the beginning of systematic, scientific, and economical road work in the State. The establishment of a State Highway Commission also makes it possible for North Carolina to receive the benefits of the Federal Aid Road Bill passed by Congress in July, 1916, which places at the disposal of the State Highway Commission for road construction in North Carolina a sum of approximately $115,000 the first year and an increasing amount each succeeding year. The State Geologist is Secretary of the State Highway Commission, and, in this connection, his work for good roads throughout the State has had a broader opportunity for accomplishing definite results. He has served for the past two years as Secretary of the American Association of State Highway Officials, and it is largely through the efforts of this Association that the Federal Aid Road Law became an accomplished fact; so that it may be said that the State has received a very direct benefit from the work of the State Geologist in this National organization.

The results accomplished since the organization of the State Highway Commission have been phenomenal and have in every way justified

the most sanguine promises made by the Survey in its appeal to the people of the State for the establishment of this Commission.

As Secretary of the North Carolina State Highway Commission, the State Geologist has kept in very close touch with all the road work throughout North Carolina and has assisted Mr. W. S. Fallis, State Highway Engineer, in every way possible. We have held frequent conferences and have together inspected road work throughout many parts of the State.

Certain road work authorized by special acts of the Legislature is still under the direct supervision of the State Geologist, such as the road work of State's prisoners, collecting of road statistics, etc. It seems to the State Geologist that preparation should be made to have all engineering road work turned over to the Highway Commission, so that it can be carried on through that office. The State Geologist, as Secretary of the Commission, is authorized and is expected to take up considerable of the executive work relating to roads in the State, and this will undoubtedly require considerable of his time, as it has in the past.

EDUCATIONAL WORK

Requests for information regarding all sorts of road problems, and for addresses on many road subjects are constantly being received by the Survey. The information requested and the speakers desired have as far as possible been supplied. In this work the Survey has had the hearty coöperation of the United States Office of Public Roads and the State Highway Commission.

During the past two years the State Geologist and associates have made the following addresses:

State Geologist at—

Hillsboro, Orange County, December 5, 1914.
Sanford, Lee County, January 14, 1915.
Hillsboro, Orange County (before County Commissioners), April 5, 1915.
Roxboro, Person County (before Road Commission of Roxboro Township, Person County), May 25, 1915.
Denver, Colorado (before meeting of Denver and Colorado Springs Automobilists), June 12, 1915.
Asheville, Buncombe County (before North Carolina Good Roads Association), July 14, 1915.
Brevard, Transylvania County (mass meeting in interest of bond issue), August 4, 1915.
Ellenboro, Rutherford County (mass meeting), August 10, 1915.
Clarkton, Bladen County (mass meeting), August 12, 1915.
Oakland, California (before Pan-American Road Congress), September 16, 1915.
Bluefield, West Virginia (Presidential address before Southern Appalachian Good Roads Association), October 14, 1915.

Bear Wallow, Henderson County (mass meeting), November 6, 1915.
Liberty and Cowee, Macon County (mass meeting in interest of bond issue), November 9, 1915.
Oak Grove, Macon County (mass meeting in interest of bond issue), November 10, 1915.
Chicago, Illinois (before meeting American Association of State Highway Officials), December 7, 1915.
Worcester, Massachusetts (before International Road Congress), December 16, 1915.
Portland, Maine (before annual meeting Maine Automobile Association), December 20, 1915.
Raleigh, Wake County (meeting State Highway Commission), January 10, 1916.
Morgantown, West Virginia (three addresses at Road Institute of the University of West Virginia), January 13, 1916.
Chapel Hill, Orange County (two addresses at Road Institute of the University of North Carolina), February 8-9, 1916.
Knoxville, Tennessee (two addresses at Road School of the University of Tennessee), February 16, 1916.
Bat Cave, Henderson County (before Hickory Nut Gap Highway Commission), February 18, 1916.
Asheville, Buncombe County (before Asheville Motor Club), February 18, 1916.
Albemarle, Stanly County (meeting in interest of Charlotte-Pinehurst Highway), March 9, 1916.
Greensboro, Guilford County (before Greensboro Chamber of Commerce), March 23, 1916.
Raleigh, Wake County (meeting State Highway Commission), April 10, 1916.
Morehead City, Carteret County, April 12, 1916.
New Bern, Craven County, April 12, 1916.
Kinston, Lenoir County, April 13, 1916.
Goldsboro, Wayne County, April 13, 1916.
Smithfield, Johnston County, April 14, 1916.
Durham, Durham County, April 14, 1916.
Hillsboro, Orange County, April 17, 1916.
Wilmington, New Hanover County (before Wilmington Highway Association), April 18, 1916.
Asheville, Buncombe County (before mass meeting in interest of Madison County roads), April 23, 1916.
Asheville, Buncombe County (before Asheville Motor Club), April 23, 1916.
Hillsboro, Orange County (before Board of County Commissioners to give advice regarding road work and bridge), May 1, 1916.
Henderson, Vance County (before annual meeting of Travelers' Protective Association), May 5, 1916.
Oxford, Granville County (before county meeting of Women's Clubs and other organizations), July 21, 1916.
Brogden Schoolhouse, Boon Hill Township, Johnston County, August 2, 1916.

Asheville, Buncombe County (before Asheville Automobile Club), August 7, 1916.
Hillsville, Virginia, August 10, 1916.
Washington, D. C. (before Meeting of American Association of State Highway Officials), August 15, 1916.
Riggsbee, Chatham County, August 29, 1916.
Lexington, Kentucky (Presidential address before Southern Appalachian Good Roads Association), September 5, 1916.
Warsaw, Duplin County, September 20, 1916.
Elkin, Surry County, September 25, 1916.
Sparta, Alleghany County, September 26, 1916.
Jefferson, Ashe County, September 27, 1916.
Raleigh, Wake County (State Fair), October 18, 1916.

D. Tucker Brown at—
Greensboro, Guilford County (before Board of Trade).
Asheville, Buncombe County (before North Carolina Good Roads Association), July 14, 1915.

H. B. Varner at—
East Bend, Yadkin County (for bond issue), February 27, 1915.
Yadkinville, Yadkin County (for bond issue), March 1, 1915.

R. P. Coble at—
Pittsboro, Chatham County (in interest of bond issue), March 6, 1915.

W. L. Spoon at—
Boone, Watauga County, November 11, 1916.

D. H. Winslow at—
Wise, Warren County, November 3, 1916.

ROAD INSTITUTE

Another form of educational work undertaken by the Survey, first in coöperation with the State University and later with the aid of the State Highway Commission and the University, has been the holding of a Road Institute at the University during the winter of each year for three consecutive years. That this Institute is supplying a vital need in North Carolina is evidenced by the fact that there has been a steady increase in its attendance, those present representing every kind of official connected with road work in the counties and townships, from the county commissioner, road commissioner, road engineer, road superintendent, road foreman, road supervisor, road trustee to private citizens interested in this work. At the first Institute, held in March, 1914, there were twenty-four counties represented, with fifty-four men attending. At the second Institute held in February, 1915, there were twenty-nine counties represented with eighty men attending. At the third Institute held in February, 1916, there were one hundred and twenty-seven men present, representing forty-three counties. At these Institutes every sort of road problem to be met with in North Carolina is discussed by experts; there is an interchange of ideas and experiences by those who are actually doing the road work in North Carolina, to

their very great mutual benefit. Demonstrations of road machinery and methods of moving dirt, surfacing, testing road materials, etc., are given. The Survey is making every effort at these Institutes to give every opportunity to those actually engaged in road building in North Carolina to hear the best lecturers that can be had; and to give the most practical instructions possible as to the best known methods of road location, construction, maintenance, demonstration, and coöperation.

The following program of the Third Road Institute will give a comprehensive idea of the character of the work taken up at these Institutes:

MONDAY, FEBRUARY 7, 1916

PEABODY HALL

9:00 a. m.—1:30 p. m. Enrollment and Assignment of Rooms.

2:30 p. m. Address of Welcome.....President Graham
2:50 p. m. Address .....Dean Stacy
3:15 p. m. The Work of the Institute.....Director Pratt
3:30 p. m. The State Highway Commission and Its Relation to County Work .....Mr. Fallis
4:30 p. m. Recess.

7:30 p. m. Social Hour. Peabody Hall.

TUESDAY, FEBRUARY 8

PEABODY HALL

MAINTENANCE AND REPAIR OF ROADS

9:00 a. m. Introduction .....Mr. Pratt
9:15 a. m. Patrol System of National Highway.....Mr. Winslow
10:15 a. m. Maintenance of New Hanover County Roads.....Mr. McGirt
Discussion—Mr. Burnett.
11:00 a. m. The Road Drag.....Mr. Snowden
11:30 a. m. The Road Hone.....Mr. Winslow and Mr. Richardson
12:00 m. County Road Organization and Financing.....Mr. White

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2:30 p. m. Demonstration of the Construction and Use of the Road Drag (in front of Peabody Hall), Mr. R. T. Brown and Mr. Clingman
4:00 p. m. Practical Instruction in Maintenance.....Mr. Winslow
5:00 p. m. Recess.

7:30 p. m. Good Roads in Other Lands (Illustrated Lecture).....Mr. Cobb

WEDNESDAY, FEBRUARY 9

PEABODY HALL

ROAD CONSTRUCTION

9:00 a. m. Location of Roads.....Mr. Williams
9:50 a. m. Needed Preliminary Survey and Investigation for County Road Work.....Mr. Coble
10:15 a. m. Steam Shovels.....Representative of Company
Discussion by Mr. Hughes and Mr. Fallis.
10:40 a. m. Use of Steam Shovel in Madison County Road Work, Mr. Clingman
11:00 a. m. Relation of Superintendents and Engineers to Highway Commission .....Mr. Williams
11:30 a. m. Relation of Contractors to Commissioners and Engineers .....Mr. Lassiter
12:00 m. Road Machinery.....Mr. Winslow and Mr. Teer
Representatives of Various Companies
12:30 p. m. Recess.
2:30 p. m. County Road Work and Its Relation to State Work, Mr. Williams
3:15 p. m. Demonstration of Use of Road Machinery on Raleigh Road:
Road Plow.....Mr. Mulligan and Mr. Carrickhoff
Road Machines.....Mr. Winslow and Mr. Teer
(In the demonstration of this machinery, a section of the Raleigh road to the east of the campus will be ditched, crowned, and brought into shape, ready either for surfacing or for maintaining as a dirt road.)
7:30 p. m. Maintenance of Roads (Illustrated).....Mr. Winslow

THURSDAY, FEBRUARY 10

PEABODY HALL

MAINTENANCE AND REPAIR OF ROADS

9:00 a. m. Instructions to Patrolmen.....Mr. Winslow
10:00 a. m. Economic Use of Prisoners in Repair and Maintenance of Roads.....Mr. Hocutt
10:30 a. m. Use of State's Prisoners in Road Construction.....Mr. Varner
11:00 a. m. Essential Qualifications for a Highway Engineer....Mr. Ambler
Discussion: Mr. Hickerson and Mr. Stacy.
11:45 a. m. Geology as an Asset to a Highway Engineer.....Mr. Cobb
12:30 p. m. Recess.

2:30 p. m. Instruction in Maintenance.....Mr. Winslow
3:30 p. m. Practical Demonstrations in Maintenance and Use of Various Road Implements,
Mr. Winslow, Mr. Fallis, Mr. Mulligan, and Mr. R. T. Brown, Demonstrators and Representatives of Various Companies

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7:30 p. m. Address .....Congressman Small
Gerrard Hall

FRIDAY, FEBRUARY 11

Peabody Hall

ROAD SURFACING MATERIALS

9:00 a. m. The Selection of Surfacing Materials for Highway Construction .....Mr. Pratt
9:30 a. m. Sand-Clay and Topsoil.....Mr. Coble
Discussion: Mr. Smith:
9:50 a. m. Report on the "Topsoil" Road Between Chapel Hill and Durham.....Mr. Hickerson
10:10 a. m. Limit of Endurance of Sand-Clay and Topsoil Roads, Mr. Winslow
Discussion: Mr. Hughes and Mr. Pennell.
10:45 a. m. Gravel Roads .....Mr. Coble
11:15 a. m. Macadam Roads .....Mr. Fallis
11:30 a. m. Bituminous Macadam.....Mr. D. Tucker Brown
11:45 a. m. Concrete .....Mr. Fallis
12:00 m. Guilford County Concrete and Bituminous Roads, Mr. D. Tucker Brown
12:15 p. m. Bituminous Materials.....Mr. James
12:30 p. m. Brick .....Mr. Pratt
12:45 p. m. Recess.

2:30 p. m. Caldwell County's $1,000 Roads.....Mr. Miller
3:00 p. m. Field Demonstrations:
Use of Abney Hand Level.....Mr. Hickerson
Testing Sand-Clay Mixtures.....Mr. Mullis and Mr. Smith
Mixing Sand and Clay.....Mr. Coble
Spreading Gravel .....Mr. Coble
7:30 p. m. Round Table: Reports from County Superintendents and Engineers.

SATURDAY, FEBRUARY 12

Peabody Hall

CULVERTS AND BRIDGES

9:00 a. m. Area of Waterway.....Mr. Hickerson

CULVERTS

10:00 a. m. Use of Various Types of Culverts.....Mr. Pratt
10:30 a. m. Terra-Cotta Culverts,
Representative of Pomona Terra-Cotta Company
Corrugated Iron Culverts.....Mr. Galvin
Concrete Culverts .....Mr. R. T. Brown
Rubble Masonry .....Mr. Fallis

BRIDGES

11:00 a. m. Steel I-Beam Bridges.....Mr. R. T. Brown
Steel Truss Bridges.....Mr. Fallis
Concrete Bridges.
Wooden Bridges .....Mr. Hickerson
12:30 p. m. Adjournment.

OFFICERS OF INSTRUCTION

E. K. Graham, President of the University of North Carolina.

M. H. Stacy, Dean of the College of Liberal Arts and Professor of Civil Engineering.

Joseph Hyde Pratt, State Geologist and Director of the Road Institute.

W. S. Fallis, State Highway Engineer.

Collier Cobb, Professor of Geology, University of North Carolina.

T. F. Hickerson, Associate Professor of Highway Engineering, University of North Carolina, and member of State Highway Commission.

Robert L. James, Highway Engineer and Associate Professor of Drawing, University of North Carolina.

John E. Smith, Instructor in Geology, University of North Carolina.

A. D. Williams, Chairman, State Road Bureau and Chief Road Engineer of West Virginia.

D. H. Winslow, Senior Highway Engineer in Charge of Field Maintenance of the U. S. Office of Public Roads and Rural Engineering, Washington, D. C.

R. E. Snowden, Highway Engineer of the North Carolina State Highway Commission.

D. Tucker Brown, Highway Engineer in Charge of Concrete and Bituminous Road Work in Guilford County.

W. A. McGirt, Chairman, Board of County Commissioners, New Hanover County.

R. A. Burnett, Road Superintendent of New Hanover County.

R. T. Brown, Highway Engineer in Charge of Road Construction of Davidson County.

J. B. Clingman, Highway Engineer of Madison County.

J. N. Ambler, Consulting Highway Engineer.
R. P. Coble, Highway Engineer of State Highway Commission.
H. B. Varner, President of State Penitentiary Board.
H. Hocutt, Highway Superintendent on Hickory Nut Gap Road.
James Mulligan, Superintendent of Construction of Roads in Davidson County.
John Carrickhoff, Foreman of Road Work, Davidson County.
J. R. Pennell, Road Engineer in Charge of Work in Greene County.
R. G. Lassiter, Road Contractor.
Hon. John H. Small, Congressman from the First North Carolina District.
R. B. White, Franklinton, N. C.
Sam D. Scott, Highway Engineer of Wayne County.
Ira B. Mullis, Highway Engineer of State Highway Commission.
Nello L. Teer, Grading Contractor.
F. R. Brown, Highway Engineer of Person County.
N. C. Hughes, Jr., Road Engineer and Superintendent of Halifax County.
Cloyd Miller, Road Superintendent in Charge of Construction of Roads in Lovelady Township, Caldwell County.
John D. Waldrop, Civil Engineer, Greensboro, N. C.

Representatives from the following companies are expected to be in attendance and give practical instruction in the use of various road machines, certain surfacing materials, and culverts:

The Good Roads Machinery Company, Kennett Square, Pa. Mr. Richardson, Representative.
E. F. Craven, Greensboro, N. C.
The General Utilities Company, Norfolk, Va.
Wyoming Shovel Company. C. H. Broward, Agent, Atlanta.
Smith & Sons Manufacturing Co., Kansas City, Mo.
Austin Bros., Atlanta, Ga.
The Barber Asphalt Paving Company, Philadelphia, Pa.
The International Harvester Company of America, Chicago, Ill.
The Thew Automatic Shovel Company, Lorain, Ohio.
Keystone Driller Company, Beaver Falls, Pa.
The Robeson Process Company, Pennington, N. J.
The Pomona Terra-Cotta Company, Pomona, N. C.
Southern Metal Culvert Association. G. P. Galvin, President.
The Atlas Portland Cement Company, New York City.
Universal Portland Cement Company.

ENGINEERING ASSISTANCE

After the creation and inauguration of the State Highway Commission, most of the engineering assistance formerly rendered by the engineers of the Survey has been done by the engineers of the Commission. The State Geologist, as member and Secretary of the Commission, has assisted the State Highway Engineer in every way possible and has made many inspections with him.

There is given below a short statement regarding the engineering work done during the past two years.

By State Geologist:

December 4, 1915, inspected Hickory Nut Gap Road.
December 4, 1915, inspected work in Madison County.
February 17, 1915, inspected road work in Madison County.
March 23, 1915, inspected at Pinehurst, Moore County, an experiment made with a road oil on sand-clay roads.
February 18, 1916, inspected Hickory Nut Gap Road work.
February 19, 1916, inspected Old Fort-Swannanoa Gap road work.
June 5, 1916, inspected road work in Madison County.
August 5-9, 1916, inspected flooded areas in McDowell, Buncombe, and Henderson counties. Also inspected convict camp in McDowell County.

By D. Tucker Brown:

December, 1914, inspection of work on the Hickory Nut Gap Road. Reconnoissance survey of Swain County link of Asheville-Murphy-to-Atlanta Highway. Inspection of work of the State convicts on the link of Central Highway near Hot Springs.
March, 1915, inspection of work of State convicts on Central Highway near Hot Springs, Madison County. Inspection of work of State convicts on Hickory Nut Gap Road, Henderson County.
April, 1915, inspection of roads of Guilford County. Preparation of specifications and contract for road improvement for Guilford County Commissioners.

By R. P. Coble:

February, 1915, location of road from Olivia, Harnett County, to Lee County line.
March, 1915, inspection and supervision of work on road between Pineview and Olivia.

By T. F. Hickerson and B. L. Field:

December, 1914, survey for relocation of a link of the Snow Camp-Graham Highway, between Snow Camp and the top of the mountain, a distance of four and one-half miles.

By Collier Cobb:

December, 1914, supervision of road work on streets of Chapel Hill during Good Roads Days.

By R. T. Brown:

January and February, 1915, inspection and estimate of seventeen miles of road in Brevard Township, Transylvania County. Inspection of road conditions and road surfacing materials at Cruso, Haywood County.

In coöperation with the State Board of Health, the Survey has prepared a report on Sanitary Jails and Camps For Prisoners. This report gives plans and specifications for the construction of three styles of camps, and also suggestions and recommendations as to how these camps shall be governed. This was published as a coöperative report of the two departments. The recommendations were submitted to the

assistant to the warden of Sing Sing Prison, who highly approved the report. The report was also presented at the annual meeting of the Southern Sociological Congress at Houston, Texas, on May the tenth, 1915, by the State Geologist. The paper was read as a joint paper by the State Geologist and Dr. W. S. Rankin, Secretary of the State Board of Health. The paper was well received and provoked considerable discussion. The report met with the endorsement of the committee. Requests have already been received for it from many states.

COOPERATION OF UNITED STATES OFFICE OF PUBLIC ROADS

During the past two years the United States Office of Public Roads and Rural Engineering has been very liberal in coöperating with the Highway Division of the State Survey, and the work has been of very great value to the cause of good roads in this State. The work has been along several lines similar to the State work.

Educational Work

Representatives of the Office of Public Roads have given lectures on good roads at the following places in North Carolina, January 1, 1915, to December 1, 1916:

No.	Place	Lecturer	Attendance	Date
2	Raleigh	E. W. James	100	January 12, 1915
1	Sanford	D. H. Winslow	150	January 14, 1915
1	Chapel Hill	D. H. Winslow	65	February 25, 1915
1	Chapel Hill	D. H. Winslow	40	February 26, 1915
1	Benson	D. H. Winslow	300	March 26, 1915
1	Smithfield	D. H. Winslow	150	April 13, 1915
1	Fayetteville	D. H. Winslow	500	April 15, 1915
1	Benson	D. H. Winslow	125	April 16, 1915
1	Cheraw	L. E. Boykin	?	April 28, 1915
1	Knap of Reeds	D. H. Winslow	70	April 30, 1915
1	Smithfield	D. H. Winslow	150	May 8, 1915
1	Clayton	D. H. Winslow	225	May 10, 1915
1	Cary	D. H. Winslow	40	May 11, 1915
1	Hopewell	D. H. Winslow	75	May 21, 1915
1	Stovall	D. H. Winslow	75	June 9, 1915
2	Princeton	V. E. Towles	2,500	June 14 & 15, 1915
1	Asheville	D. H. Winslow	200	July 15, 1915
1	Boon Hill	D. H. Winslow	31	July 28, 1915
1	Raleigh	D. H. Winslow	80	August 26, 1915
1	Coats	D. H. Winslow	60	September 27, 1915
1	Halifax	D. H. Winslow	150	October 4, 1915
1	Washington	L. E. Boykin	?	October 27, 1915
1	Belhaven	H. M. Lynde	125	November 30, 1915
4	Chapel Hill	D. H. Winslow	122 ea.	Feb. 8-11, 1916, incl.
1	Raleigh	D. H. Winslow	30	February 18, 1916
1	Wilmington	D. H. Winslow	100	March 7, 1916
1	Wilmington	D. H. Winslow	20	March 7, 1916
1	Albemarle	W. L. Spoon	300	March 9, 1916
2	Lumberton	D. H. Winslow	35	March 9 and 10, 1916

No.	Place	Lecturer	Attendance	Date
1	Oxford	D. H. Winslow	400	March 14, 1916
2	Elizabeth City	D. H. Winslow	135	Mar. 31 & Apr. 1, '16
1	Smithfield	D. H. Winslow	200	May 2, 1916
1	Goodwin	D. H. Winslow	20	May 3, 1916
1	Goodwin	D. H. Winslow	60	June 5, 1916
1	Wrightsville Beach	D. H. Winslow	350	June 21, 1916
1	Wrightsville Beach	J. E. Pennybacker	---	June 21-23, 1916
1	Greensboro	W. L. Spoon	135	July 3, 1916
1	Raleigh	D. H. Winslow	50	July 27, 1916
1	Fayetteville	D. H. Winslow	80	July 31, 1916
1	Raleigh	H. M. Lynde	75	August, 1916
1	Boon Hill District	D. H. Winslow	90	August 2, 1916
1	Johnston County	D. H. Winslow	200	August 25, 1916
1	Oxford	D. H. Winslow	60	September 7, 1916
1	Henderson	D. H. Winslow	200	September 27, 1916
1	Yanceyville	W. L. Spoon	300	October 2, 1916
3	Raleigh	D. H. Winslow	1,200	October 18-20, 1916
1	Snow Hill	H. M. Lynde	25	October 30, 1916
1	Wise, Warren County	D. H. Winslow	60	November 3, 1916
1	Johnston County	D. H. Winslow	30	November 4, 1916
2	Boone	W. L. Spoon	430	November 11, 1916
2	Greensboro	H. M. Lynde	50	November 22.23,1916
1	Rosemond	D. H. Winslow	40	November 23, 1916

Engineering Assistance

Engineers from the Office of Public Roads have supervised construction of object lesson roads in several counties; have assisted in the construction of post roads; and have given advice and inspection in regard to certain special assignments on roads, and the building of bridges, and the making of bridge designs, which is given in detail as follows:

Object Lesson Roads

(North Carolina, December 1, 1914, November 30, 1916.)

Place	Kind of Work	Length	Cost	Engineer	Date
Buncombe County	Bit. macadam	2.38 mi.	$ 14,555.23	B. H. Burrell	May 10, 1915 Aug. 11, 1915
Alamance County, Burlington.	Topsoil	.68 mi.	715.90	Mack Galbreath	Jan. 11, 1915 April 15, 1915
Alamance County	Bit. resurfacing	1.5 mi.	1,523.47	W. H. Lynch J. H. Eldridge	June 15, 1915 Aug. 26, 1915

POST ROADS

McDowell County	Earth grading	14	$ 41,875.94	W. H. Rhodes P. A. Rideout J. H. Dodge	July, 1914 Nov., 1916
Davie, Forsyth and Iredell Counties	Topsoil Bit. macadam	44	96,318.30	H. L. Arbenz Mack Galbreath H. S. Parry F. A. Davis	July, 1914 Aug., 1915

SPECIAL ASSIGNMENTS—ADVICE AND INSPECTION

Place	Kind of Work	Engineer	Date
Warren County	Inspection of road and report	D. H. Winslow	Apr. 27, 1915
Randolph County	Inspection of road and report	E. W. James	Apr., 1916
Little Switzerland	7 mi. of mountain location	H. K. Craig	June 14, 1916 July 13, 1916
Haywood County	Inspection	H. K. Craig	Aug. 5, 1916
Asheville Highway	Inspection and estimate of repair	H. K. Craig	July 26, 1916 Aug. 4, 1916
Charlotte-Pinehurst Rd.	Inspected designation of route	H. K. Craig	June 7, 1916
Concord-Charlotte Rd.	Inspected designation of route	H. K. Craig	June 14, 1916
Hickory	Surveys and advice	H. K. Craig	May 29-31, '16
Albemarle	Preliminary surveys	H. K. Craig	April 29, 1916 June 14, 1916
Ashboro	Advice and inspection, 80 miles of road	H. K. Craig	Mar. 28, 1916 April 27, 1916
Wayne County, (Goldsboro)	Surveyed 38 miles of road	H. K. Craig	Feb. 22, 1916 Mar. 27, 1916

BRIDGE DESIGNS

Location	No.	Kind	Size	Date
Richmond County	1	Steel highway bridge	75′ span	April, 1915
Hyde County	8	Wood bridges		Aug.-Oct., 1915
Anson and Stanly Counties	1	Steel highway bridge	3-120′ 8- 27′	September, 1916
Durham County	1	Steel highway bridge	68′	March, 1915
Durham County	1	Steel highway bridge	125′	March, 1915
Durham County	1	Steel highway bridge	2-100′	March, 1915
Durham County	1	Steel highway bridge	2-100′	March, 1915
Forsyth County	1	I-Beam cone floor	2- 30	June, 1915

NOTE—The four bridges in Durham County were inspected by Mr. O. W. Childs upon completion. This office also made the surveys for the bridge sites.

SPECIAL HIGHWAYS

CENTRAL HIGHWAY

A special inspection trip was made during April, 1916, of the Central Highway in order to determine just how much of this highway was completed and whether arrangements could be made with the county officials for a patrol system of maintenance on this highway. The inspection trip started at Morehead City, April 12, the party consisting of:

E. W. James, Chief of Maintenance, U. S. Office of Public Roads.
D. H. Winslow, Senior Highway Engineer, U. S. Office of Public Roads.
W. S. Fallis, State Highway Engineer of North Carolina.
Joseph Hyde Pratt, State Geologist, Secretary, State Highway Commission.

Meetings at which talks were made regarding the work on the Central Highway and the patrol system of maintenance was discussed, were held at the following places: Morehead City and Newport, Carteret County; New Bern, Craven County; Kinston, Lenoir County; Goldsboro, Wayne County; Smithfield and Clayton, Johnston County; and Durham, Durham County. From Durham west the inspection was made by E. W. James, W. S. Fallis and W. L. Spoon. When Burke County was reached, it was found that very little work had been done on the Central Highway and it was impossible to take over the maintenance of that portion of the Central Highway in Burke County. Since that time three townships in that county have voted bonds and will build their links of the Central Highway. As a result of these meetings, arrangements were made for the systematic maintenance by the patrol system of that portion of the Central Highway between Morehead City and the Burke County line. Within another year the Central Highway should be completed, graded and surfaced its entire distance of nearly 500 miles.

On this same trip the highway from Winston-Salem to Statesville via Mocksville was inspected and arrangements made for maintaining it by the patrol system. That portion of the Central Highway between Morehead City and Durham is in charge of Mr. D. H. Winslow, and that from Durham to the Burke County line and via Winston-Salem is in charge of Mr. W. L. Spoon. Both of these men are engineers of the United States Office of Public Roads, and the whole work is under the supervision of Mr. E. W. James, Chief of Maintenance, United States Office of Public Roads, and W. S. Fallis, State Highway Engineer of North Carolina.

Wilmington-Fayetteville Highway

This highway has been surveyed and sufficient interest aroused in its construction to insure its completion within the next year.

Wilmington-Goldsboro Highway

Several meetings have been held in the interest of this highway and it is believed that the several counties through which it passes will provide the funds for its construction as soon as it is surveyed and located.

Charlotte-Pinehurst Highway

Several links of this highway, although its entire location has not been made, are now being built. The complete location will be made as soon as possible, and there is every reason to believe that the counties and townships will provide the necessary funds for its construction, which will be done under the supervision of the State Highway Commission.

NORTH CAROLINA GOOD ROADS ASSOCIATION

The North Carolina Good Roads Association was organized in 1901, largely through the efforts of the North Carolina Geological Survey, under the leadership of Professor J. A. Holmes, who was then State Geologist. Since its organization, this Association and the Survey have worked in very close coöperation in the promotion of the good roads cause in the State. During the past two years two conventions have been held by this Association in coöperation with the Survey, one at Asheville, July, 14, 15, 16, 1915, and one at Wilmington, Wrightsville Beach, June 21, 22, 23, 1916. This latter convention was the largest road convention ever held in the State or in the South. About twelve hundred delegates were registered, representing practically every county in the State. The slogan of the convention was "State Roads," and it is believed that an impetus was given to the building of long continuous stretches of good road connecting county seat with county seat, and the eastern with the Piedmont and mountain sections of the State. A getting away from the old idea of simply building short stretches of neighborhood road, resulting in a few miles of good road, followed by many miles of very bad road, is felt to have been a very distinct advance. As a direct result of this convention, there is a movement on now for the building of certain intra-State highways, which extend across many counties of the State.

The Survey also coöperated with the North Carolina Good Roads Association and with the State Highway Commission in the preparation of a Road Maps and Tour Book of Western North Carolina. The territory covered by the book takes in all of the main traveled highways of Western North Carolina west of a line drawn from Danville to Charlotte, and also shows the roads from Spartanburg and Greenville, S. C., into Asheville. It is planned to continue the routing of the State and issue another book covering the balance of the State.

In this book information is given relative to hotels, boarding houses, garages, etc., along these routes. It is of especial value to automobilists, tourists, and cyclists. Also, it is of great value to those seeking information regarding Western North Carolina, as it contains descriptive matter relative to all the counties.

The book contains 75 maps, each covering 25 miles, and on these maps are shown the roads in detail, each being illustrated with scenes along the road. Bridges are indicated (showing kind); railway crossings as to grade and whether overhead or underhead; mileage in each direction from town to town; and mileage to intermediate points is indicated every two miles. Descriptive matter is included as to the construction of roads, the condition at various times of the year, etc.

This book is published in two bindings: a red leather binding with gold titles and a red cloth binding with black titles. It is a convenient size for the traveler, being 5 inches by 9¾ inches and contains 159 pages. It is divided as follows:

Part I—Road Maps, 120 pages.

Part II—Description of counties traversed by highways mapped in Part I, 39 pages.

ROAD EXHIBITS

Realizing that the industrial development of North Carolina is largely dependent upon the construction of good roads throughout the State; that the prosperity of the State and its progressiveness are also largely dependent upon its mileage of good roads; and that one of the best advertisements a State can have is a system of well-built and well-maintained highways, the Highway Division of the Survey has sought in every way possible to disseminate knowledge in regard to the value of good roads and the best methods for obtaining them. One of the avenues employed in bringing this knowledge before the people of the State has been in the form of exhibits at State and local fairs, good roads associations, etc. These exhibits have consisted of photographs illustrating the character of roads built throughout the various counties; maps and charts showing the location of the various highways and their connections with highways of adjoining States; samples of road materials, such as are found in the State and are of value in the construction of the roads; road models, loaned by the United States Office of Public Roads, and showing various types of road construction; and publications descriptive of the roads of the country through which they pass. Such exhibits were made at:

Asheville, N. C., July 14, at the annual meeting of the North Carolina Good Roads Association.

Bluefield, West Virginia, October 14, 1915, at the annual meeting of the Southern Appalachian Good Roads Association.

Wilmington, Wrightsville Beach, N. C., June 21, 22, 23, 1916, at the annual convention of the North Carolina Good Roads Association.

Lexington, Kentucky, September 5-8, 1916, at the convention of the Southern Appalachian Good Roads Association.

Exhibits were made also at the following fairs:

Anson County Fair, at Wadesboro, N. C., October, 1915.
Mecklenburg County Fair, at Charlotte, N. C., October 26-27, 1915.
State Fair, at Raleigh, October 26-29, 1915.
Robeson County Fair, at Lumberton, N. C., November, 1915.
Wayne County Fair, at Goldsboro, N. C., October 15, 1916.
State Fair, at Raleigh, N. C., October 18-23, 1916.
Orange County Fair, at Hillsboro, N. C., October 25-26, 1916.
Rally Day, at Chapel Hill, N. C., November 3, 1916.

ROAD STATISTICS

The Survey has continued to coöperate with the United States Office of Public Roads and Rural Engineering in the collection of data relating to the financing and building of roads in North Carolina. These data enable us to take stock of where we stand along this line and help us to realize the efficiency or nonefficiency of our present methods by comparing what we are spending with what we are getting for this expenditure. It might be stated here, however, that the report for 1914 (the most complete yet obtained) is still in the hands of the Commissioner of Labor and Printing, not published because of lack of printing funds. The value of this report to the people of the State is being greatly diminished because of its not being published at the proper time. The collection and tabulation of these data cost us a great deal in money and time, and the nonpublication of this report is a distinct loss to the State.

It is with a distinct satisfaction that the Survey is now seeing many of the principles which it has been enunciating for many years being put into practice. Public opinion, however, has just begun to awaken and needs guidance in the paths of efficiency, economy, and coöperative effort between local and State officials in an endeavor to get the greatest value from the public moneys spent in terms of the most desirable locations from the standpoint of service to the people as well as most efficient grade; durability and surfacing materials used in relation to density of population; mileage obtained; and last, but of greatest importance, efficient maintenance; ever keeping in mind the desirability of having a *system of roads,* beginning somewhere and ending somewhere, avenues for intercommunication which will make our State a unit physically, socially, and spiritually. To mould public opinion along the lines suggested is the future work of the Survey, the State Highway Commission, the various road organizations, and the duty of all forward looking citizens.

HYDROGRAPHY

WATERPOWERS

North Carolina has been bountifully supplied with waterpowers. It has been estimated that there is an available amount of about 450,000 horse power. In 1908 the Census Bureau declared that about 141,000 horse power of this was then developed. Since 1908 the electric power developed in this region has nearly doubled; so probably half of the State's waterpowers are now under harness.

CONTROL

In 1915 two companies, the Southern Power Company and the Carolina Power and Light Company, controlled 75 per cent of the developed waterpower, and eight corporations controlled 94 per cent of the waterpower. Forty-nine municipalities have only 1 per cent of the waterpower. The percentage of strictly public-service power controlled by the several corporations is greater even than the above figures would indicate.

PROTECTION

Waterpowers cannot well be utilized beyond their minimum capacity without auxiliary power. The problem with power companies is to raise the minimum flow during two or three summer months. This may be done by building impounding reservoirs or by improving the land cover of the watershed. An unburned forest cover prevents erosion and regulates the flow of streams, making them higher in dry weather and lower in flood-time. For the protection of our waterpower, the prevention of forest fires is most important.

STATE CONTROL OF WATERPOWERS

It is believed that all waterpowers in North Carolina, other than those controlled by the Federal Government, should be subject to State control and subject to a reasonable charge to the State for the use of the water.

GAUGING STATIONS

For many years the State Survey, in coöperation with the Federal Survey, maintained thirty gauging stations in North Carolina. The statistics relating to information obtained regarding our waterpowers have been published in Bulletins 8 and 20. During the past two years it has been impossible for the State Survey to coöperate in this work, and therefore only a few stations were maintained during the past two years.

At the following gauging stations in North Carolina continuous stream-flow records were obtained during the period December 1, 1914 to November 30, 1916:

Roanoke River at Old Gaston.
Yadkin River at Donnoha.
Yadkin River near Salisbury.
South Fork New River near Crumpler.
North Fork New River near Crumpler.
French Broad River at Asheville.
Little Tennessee River at Judson.
Tuckasegee River at Bryson City.
Hiwassee River at Murphy.
Valley River at Tomotla.
Nottely River near Ranger.

The stations near Crumpler were discontinued September 30, 1916. Records for the stations on Little Tennessee and Tuckasegee rivers were furnished by the Knoxville Power Company.

DRAINAGE

One of the undertakings of the North Carolina Geological and Economic Survey has been the promotion of the reclamation of the swamp lands of the Coastal Plain Region and the overflowed areas of Piedmont and Western North Carolina, through drainage. The object of this reclamation is threefold: first, to increase the healthfulness of the section of the country in which the swamp or overflowed areas exist; second, to make a nonproducing area productive, thus increasing the revenue of the commonwealth; and, third, to facilitate intercourse between communities adjacent to these swamp areas by the construction of good roads, which always follows the drainage of any swamp area.

The work of the Survey in this connection has consisted in: helping to organize and foster the work of the North Carolina Drainage Association, which banded together a number of progressive citizens who undertook to bring to the attention of our General Assembly the need for legislation to promote and render possible this mammoth undertaking; helping to draft the North Carolina Drainage Law, which was passed by the Legislature of 1909, together with amendments passed by successive Legislatures; approving the appointment of drainage engineers and the expenses of preliminary examinations of districts; publishing and distributing circulars giving the briefs and decisions regarding cases taken to the Supreme Court for ultimate decisions on points affecting the work of drainage districts, and the publication of the Drainage Law with amendments and a set of Forms for Organizing Drainage Districts. The use of the forms prepared is greatly facilitating the ease and accuracy with which these drainage districts can be organized. The State Geologist has been able, through correspondence and by personal visits to districts and addresses at meetings, to straighten out many tangles which have arisen in the organization of districts, and has offered his services in every way possible toward the promotion of this great work.

NORTH CAROLINA DRAINAGE ASSOCIATION

The Survey has coöperated with the North Carolina Drainage Association in holding annual conventions for the discussion of drainage problems by experts, and interchange of experiences and ideas by those actually engaged in the drainage work; and it is felt that these conven-

tions have been a stimulus to the work, encouraging the formation of new districts by showing landholders the necessity for drainage and the ease with which it can be accomplished through coöperative effort, made possible by the North Carolina Drainage Law.

Through these conventions an interest has been awakened in general farm drainage, particularly tile drainage, which will undoubtedly add untold values to most of our farms now under cultivation, and will be the ultimate process in bringing the swamp and overflowed land to yield their greatest possibilities. At the convention held in Greensboro in November, 1916, reports were made on the result of tile drained fields, and these reports showed results which were not only gratifying, but astonishing as well. Returns of from fifty to one hundred per cent on money invested in tile drain were reported as having been received even the first year after drainage. The proceedings of these conventions have been printed and distributed by the Survey from year to year; but, owing to the lack in our printing fund, the proceedings of the 1915 convention are still in the hands of the Commissioner of Labor and Printing.

The Eighth Annual Convention of the North Carolina Drainage Association was held at Belhaven, N. C., November 29, 30, and December 1, 1915. Since the organization of this association eight years ago there has not been held a more enthusiastic and interesting convention than this one at Belhaven. Twenty-one counties were represented, as follows: Beaufort, Bertie, Carteret, Craven, Currituck, Edgecombe, Guilford, Hertford, Hyde, Lenoir, Mecklenburg, New Hanover, Orange, Pasquotank, Pitt, Robeson, Tyrrell, Wake, Washington, Wayne, and Wilson. There were also representatives from District of Columbia, Missouri, Ohio, and Virginia. There were 116 registered delegates, 102 of whom were from outside of Belhaven. Representatives of various dredging and contracting companies, banks interested in the purchase of drainage bonds, and companies producing tile were present. The Drainage Law was thoroughly discussed, not only by the delegates but by the bond dealers and contractors, and it is believed that some important points were brought out which will undoubtedly result in the solution of many points of the Drainage Law which have not proven entirely satisfactory.

The officers who were elected for the year 1916 were: President, P. H. Johnson of Pantego; Secretary-Treasurer, Joseph Hyde Pratt of Chapel Hill; First Vice-President, M. W. Thompson of Greensboro.

The Committee on Resolutions made the following report:

Report of Committee on Resolutions

The people of North Carolina are to be congratulated on the splendid progress made in the drainage of the swamp and overflowed lands of the State through the operation of the North Carolina Drainage Law, which has constantly increased the wealth of the State. Looking back upon the conditions which prevailed seven or eight years ago, we are pleased to see the change of sentiment toward drainage as well as the remarkable appreciation shown toward good roads and other progressive movements of the State. We realize that all these progressive movements, particularly drainage and good roads, are mutually helpful, and that success in one must necessarily increase the efficiency of the other: Therefore, be it

Resolved, That whereas it is universally recognized that efficient drainage of the roadbed is one of the first essentials in the construction of good highways, and the work of this Association is to that extent necessarily identified with highway improvement; that an earnest invitation be extended all highway engineers and road superintendents of the State to attend the next and succeeding meetings of this Association, and the sympathetic aid of the State Highway Commission is requested to this end; and that a copy of this resolution be forwarded to the State Highway Engineer with a request that he lay same before the State Highway Commission.

Resolved, That this Association recognizes the valuable assistance of the coöperation of the United States Office of Public Roads and Rural Engineering of the United States Department of Agriculture, in the furtherance of the drainage movement and the organization of drainage districts since the enactment of the State Drainage Law. The detail of a representative of the Department for exclusive service in this State has been of exceeding value in disseminating information and making preliminary investigations as to the feasibility of drainage in many sections. This Association takes pleasure in acknowledging this obligation and in expressing its thanks to the United States Department of Agriculture, and requests the Secretary of the Association to forward a copy of this resolution to the Secretary of Agriculture.

Resolved, That the extension of drainage, both in the organization of drainage districts and the drainage of individual farms, demands an increased number of drainage engineers competent to advise and make plans for effective drainage. This Association recognizes the instruction now offered as a part of the curriculum of the North Carolina College of Agriculture and Mechanic Arts in the various phases of drainage, but expresses the opinion that this college course may profitably be extended. This Association, therefore, recommends that the course in drainage at the North Carolina College of Agriculture and Mechanic Arts, which is preëminently the college for the teaching of agriculture, shall be so enlarged as to meet the present and future demands for the drainage of our wet lands; that the authorities of this college are invited to send as a delegate to the Annual Convention of this Association at least one representative of the student-body, pursuing the current course in drainage; that a copy of this resolution be forwarded to the president of the college and also a copy to the president of the Agricultural Club at the college.

Resolved, That this Association go on record in expressing its appreciation of the work of the North Carolina Geological and Economic Survey, not only in forwarding the drainage and good roads work of the State, but in the development and advertisement of the natural resources of North Carolina.

Resolved, That the North Carolina Drainage Association shall have two Vice-Presidents at large, one to be charged with the interests of tile and farm drainage and the other with the interests of the district drainage of the State and in the Conventions of the North Carolina Drainage Association.

Resolved, That the North Carolina Drainage Association shall have a standing Publicity Committee of one, whose duty it shall be to coöperate with the Secretary of the Association in advertising the work and in bringing the results of drainage to the notice of the public.

Resolved, That this Convention expresses its deep regret at the death of our esteemed former member, Mr. B. E. Rice, Industrial Agent of the Norfolk Southern Railroad, and its appreciation of his faithful work in coöperation with this Association in the development of the State; and the Secretary is herewith requested to extend the condolences of this Association to the bereaved family.

Resolved, That this Association extends thanks to the city of Belhaven and its officials for the hearty welcome and support given the delegates to the Convention, to the Belhaven Board of Trade, the Board of County Commissioners of Beaufort County, to the citizens of Belhaven and Beaufort County for the warm hospitality and the many courtesies extended to our delegates, and to the newspapers of Beaufort County for advertising and reporting the Convention.

Resolved, That the thanks of this Association be extended to the Norfolk Southern Railroad for its courtesy in providing a special train for the convenience of delegates.

Resolved, That we extend to the people of Hyde County our thanks and appreciation for providing the means by which we were enabled to visit the Lake Mattamuskeet Drainage District and partake of their generous hospitality.

NINTH CONVENTION OF NORTH CAROLINA DRAINAGE ASSOCIATION

The Ninth Annual Convention of the North Carolina Drainage Association was held in Greensboro, N. C., November 22-23, 1916. The following twenty-one counties were represented at the Convention: Alamance, Beaufort, Buncombe, Cabarrus, Catawba, Craven, Durham, Edgecombe, Forsyth, Guilford, Hyde, Lenoir, Mecklenburg, New Hanover, Orange, Randolph, Rowan, Robeson, Sampson, Stokes, Wake. The Southern and Seaboard Air Line Railways were officially represented, as well as a number of bond companies from Ohio and Georgia. While the attendance at this Convention was not as large as at some of the others, yet the proceedings were most constructive and instructive.

One of the features of this Convention was a very complete discussion of the subject of farm drainage, which includes tile drainage, terracing, etc. The Association had offered prizes to the member of the Boys' Club who presented the best plan for tile draining a field, and to the farmer who presented the best report on a field which he had tile drained. The prize for the best tile drained field was given to Mr. A. L. French, of Draper, Rockingham County, and the medal was

awarded to Lawrence L. Connolly, of Ledger, N. C., for the best plan for a tile drained field. There were quite a number of reports from farmers who have engaged in tile drainage and results of from fifty to one hundred per cent on money invested were reported.

As the use of tile drain is the ultimate process in drainage and is one which will add great value to our agricultural lands, it is felt that much good will be accomplished from the educational work along this line.

The following resolutions were passed by this Convention:

Resolutions

The North Carolina Drainage Association, in annual session in the city of Greensboro, North Carolina, submits the following declaration and resolutions in behalf of the public activities to which it is committed:

This Association was organized in the city of New Bern in 1908 for the purpose of promoting the reclamation and more efficient drainage of wet and overflowed lands in the State. As a result of the coöperative efforts of this Association, a modern drainage law was drafted, and was enacted into law by the General Assembly of the State at its session of 1909. Under this law as amended from time to time many drainage districts have been established, many thousands of acres of wet and overflowed lands have been reclaimed, and many other thousands of acres of lands which were subject to occasional overflow and consequent damage to growing crops have been efficiently drained, and all these lands are now in a productive condition. The net results of these activities represent an increment to the wealth of the State estimated by some as high as $50,000,000, thereby increasing the revenue of the State and counties and multiplying the volume and value of farm products and contributing to the welfare and prosperity of all the people.

We urge upon the intelligent and progressive citizenship of the State a continued interest in the work of the Association, particularly by attending its sessions and participating in the educational processes intended to extend the benefits of drainage to every locality.

We commend to the Legislature of the State due consideration of the importance of maintaining a wise and workable drainage law, and we express the hope that certain amendments which will be proposed to the Legislature at the coming session of 1917 will be promptly enacted into law. To this end we urge the Association at this meeting to authorize and direct the Legislative Committee to hold a meeting in the city of Raleigh during the coming session of the Legislature, at such time as may be designated by the President and Secretary of the Association, for the purpose of presenting to the appropriate legislative committees the necessity for these amendments and their enactment without material change.

That the President and Secretary of the Association be requested to exercise unusual efforts, by way of publicity and correspondence, to secure a large and representative attendance of citizens at the next annual meeting of the Association.

It is gratifying to know that North Carolina has been in a way the pioneer in this reclamation work among the Southern States, and that since our law was put into operation the Survey has been called upon by other Southern States to assist them in regard to their legislation, and in many instances these States have used the North Carolina Drainage Law as a model.

The State Geologist is one of the Board of Governors of the National Drainage Congress, and as such has been able to keep in close touch with the drainage work of the country and to obtain considerable information regarding drainage that has been of value to the work in this State. The State Geologist represented the State at the meeting of the National Drainage Congress held at San Francisco in 1915.

RESULTS OF DRAINAGE IN NORTH CAROLINA

Up to the present time there have been organized 123 districts under our law, 38 of which have been fully organized and the drainage completed; 20 have been completely organized, and the drainage work is now being done; 42 are still in the process of organization; 11 have been organized, but for one reason or another the work has not started in the construction of ditches and canals; and 12 have been abandoned.

It is estimated that the cost of draining the swamp land varies from four to six dollars per acre. The cost of clearing the land after drainage is from five to six dollars per acre, and the yield from this land varies from twenty to one hundred bushels of corn to the acre, a bale of cotton, or seventy to one hundred bushels Irish potatoes, giving two yields to the season. In fact, it has been demonstrated that this land will produce in abundance any crop which can be grown in this climate. When it is realized that the taxable value of this land before being drained is from twenty-five cents to one dollar per acre, that it costs from ten to fifteen dollars per acre to drain and clear it, and that after that is done, it can be sold at from fifty to one hundred and fifty dollars per acre, some idea can be gained of the tremendous import to the State of draining approximately 800,000 acres of swamp lands. A conservative estimate of the net agricultural value to the people of Eastern North Carolina through this drainage work is fifty million dollars, without even taking into consideration the gain from the standpoint of health.

FARM DRAINAGE INVESTIGATIONS IN NORTH CAROLINA

By United States Office of
Public Roads and Rural Engineering

The following is a statement of the preliminary examinations and surveys which have been made by the United States Office of Public Roads and Rural Engineering, on the swamp and overflowed areas during the years 1915 and 1916. Ten examinations of a preliminary nature have been made, covering a total area of approximately 28,000 acres, scattered over nine counties. In addition, two reconnoissance surveys were made in Brunswick County, one of the land in the vicinity of Caw Caw and Scippeo Swamps and the other of the land in the vicinity of Big and Little Alligator Swamps.

PRELIMINARY EXAMINATIONS

SWAMP LANDS

District	Area	County	Date Examined	Engineer
R. J. Ransour tract	800	Bladen	April 5, 1915	F. R. Baker.
Grindool Creek	5,000	Pitt	May 24, 25, 1915	H. M. Lynde.
Caw Caw Swamps*	2,500	Brunswick	Jan. 11, 1916	H. M. Lynde.
Alligator Swamps*	10,900	Brunswick	April 26, 1916	H. M. Lynde.

OVERFLOWED AREA

South Yadkin River	1,400	Iredell	Feb. 23, 25, 1915	H. M. Lynde.
Snow Creek	450	Iredell	Feb. 24, 1915	H. M. Lynde.
Dutchman Creek	1,200	Davie	Feb. 26, 27, 1915	H. M. Lynde.
Second Broad River and tributaries	2,200	Rutherford	May 11, 12, 13, 1915	H. M. Lynde.
Sandy Run Creek	200	Cleveland	Nov. 2, 1915	F. R. Baker.
Wolf Island Creek	3,500	Rockingham	July 7, 1916	F. R. Baker.

*Reconnoissance survey of Caw Caw Swamp was made during the period April 18-25, 1916. Of Alligator Swamp, October 4-5, 1916.

Mr. Lynde read a paper before the Eighth Annual Convention of the North Carolina Drainage Association on "Tile Drainage Pays" and at the Ninth Annual Convention on "Some Special Problems in Tile Drainage." Mr. Baker read a paper before the Ninth Annual Convention of the North Carolina Drainage Association on "Erosion and Its Prevention."

DRAINAGE EXHIBITS

The Survey has prepared an exhibit consisting of panels of photographs illustrating the different steps in the drainage of our swamp lands, and pictures of crops growing on these reclaimed areas. The drainage districts have also been plotted on a map of the State, showing the reclaimed areas. This State map shows also the swamp lands of the State so that by looking at the map you can see the portions of the swamp lands which have been reclaimed, and portions which are still unreclaimed. This drainage exhibit also consists of literature relating to the drainage work of the State, and containing pamphlets giving data relating to the drainage work. In the exhibit there are also charts of drainage districts showing the location of canals, etc. Displays containing all or a part of the above exhibit were made at:

Georgia Drainage Congress, Albany, Georgia, May 13, 1915.

National Drainage Congress, San Francisco, September, 1915.

State Fair, Raleigh, October 26-29, 1915.

Eighth Convention of the North Carolina Drainage Association, at Belhaven, November 29-30 and December 1, 1915.

State Fair, Raleigh, October 18-23, 1916.

Chapel Hill, N. C. (Rally Day), November 3, 1916.

Ninth Annual Convention of the North Carolina Drainage Association, Greensboro, November 22-23, 1916.

It is believed that this exhibit is of great value to the State, in that it shows in a very graphic manner the great possibilities of these swamp lands, and the results which can be obtained through this drainage work. It will undoubtedly serve to interest home seekers and capitalists in this section, as the drainage makes the section healthful as well as productive, and therefore attractive to the home seeker. The wonderful fertility of the soil as shown from the photographs and statistics holds a wonderful promise to the capitalist.

NORTH CAROLINA DRAINAGE LAW

Although marvelous results have been accomplished in drainage and the reclamation of our swamp and overflowed lands, yet there is need of amendments to make it still more efficient. The following legislation is suggested:

A Bill to be Entitled An Act to Amend Chapter 442 of the Public Laws of 1909, Enacting a General Drainage Law and Providing for the Establishment of Drainage Districts, and the Act Amendatory Thereof, Being Chapter 67 of the Public Laws of 1911, and for Other Purposes.

The General Assembly of North Carolina do enact:

Section 1. That section 14 of chapter 67 of the Public Laws of 1911 and chapter 235 of the Public Laws of 1915 be, and the same are, hereby repealed, and in lieu thereof the following shall be substituted: That the State Treasurer shall pay the compensation and expenses of the Drainage Engineer and his necessary assistants, as provided in section 2 of chapter 442 of the Public Laws of 1909, which payment shall be based upon an itemized statement approved by the clerk of the Superior Court before whom the drainage proceeding is pending, and also approved by the State Geologist. Such payment shall be made upon the warrant of the State Auditor out of any money in the Treasury not otherwise appropriated. The total amount to be paid by said Treasurer shall not exceed at any time the sum of fifteen thousand dollars ($15,000), after deducting the amounts refunded to the Treasurer from time to time. Before any warrants shall be drawn by the Auditor, or payment made by the Treasurer on account of any district, the bond by said petitioners required by said section 2 shall be first approved by the Attorney-General. Not more than two thousand dollars ($2,000) shall be advanced to any one drainage district. The amount so advanced to any drainage district shall be refunded to the said Treasurer by the Board of Drainage Commissioners out of the first moneys which shall come into their hands from the sale of bonds or otherwise after the district shall be established, or the same shall be refunded by the petitioners or the sureties on their bond, in the event the district shall not be established. If the drainage district is established and the Board of Drainage Commissioners shall fail for sixty days to refund to the said Treasurer such sum or sums as may have been advanced to the district out of the first moneys which shall be paid to the district, either from the sale of bonds or otherwise, then each of the members of the

said Board of Drainage Commissioners shall be guilty of a misdemeanor and shall be fined or imprisoned at the discretion of the court. As a further remedy the Attorney-General, upon request from the said Treasurer, is hereby authorized and directed to institute suit against the Board of Drainage Commissioners and the petitioners and the sureties on their bond for the amount so advanced by the said Treasurer. If the district shall not be established, then and in such event the petitioners and the sureties on their bond shall be and become liable to the State Treasurer for the repayment to said Treasurer of the sum theretofore advanced to said district, and if such sum shall not be repaid to the State Treasurer within sixty days after the final order of the court refusing to establish such district, then and in such event the Attorney-General, upon request of the said Treasurer, is hereby authorized and directed to institute suit in the Superior Court of the county in which the district is sought to be established against all the petitioners and the sureties on their bond. If the court shall finally determine against the establishment of any district, it shall be the duty of the clerk of the Superior Court of the county in which the proceeding for the establishment of the district was pending to notify in writing, by registered mail, both the State Treasurer and the Attorney-General of the State.

Section 2. That section 12 of chapter 442, Public Laws of 1909, be amended by striking out all the remainder of such section after the words "construction of the ditch," in line 8, and inserting in lieu thereof the following: The lands benefited thereby shall be separated into eight classes. The land receiving the highest benefit shall be marked "Class A"; that receiving the next highest benefit, "Class B"; that receiving the next highest benefit, "Class C"; that receiving the next highest benefit, "Class D"; that receiving the next highest benefit, "Class E"; that receiving the next highest benefit, "Class F"; that receiving the next highest benefit, "Class G"; and that receiving the smallest benefit, "Class H."

The lands of any one landowner need not necessarily all be included in any one class, but may be in different classes according to benefit received. Where the lands in any one contiguous body and under one common ownership are separated into different classes, the number of acres in each class shall be ascertained and reported, and the boundaries of each class shall be intelligently described in the final report and be so marked on the map as to have reference to such description. If the entire contiguous body of land shall be in one class only, the engineer and the viewers shall only be required to mark on the map the boundary lines of such land, the name of the owner and the number of acres therein, and the classification thereof.

It shall be the duty of the engineer and viewers to survey and have prepared a map showing the boundary lines of the entire district, the boundary lines of each tract of land owned by each person or several persons jointly, the class or classes into which such land has been separated, and also to compute and show the number of acres in each tract and the different classes of each tract, and mark the name of the owner on the map. In their report they shall also show the total number of acres owned by each landowner and the total number of acres benefited thereby. The total number of acres in each class in the entire district shall be determined and presented in tabulated form.

The scale of assessment upon the several classes of lands reported by the engineer and viewers shall be in the ratio of eight, seven, six, five, four, three, two, and one; that is to say, as often as eight mills per acre is assessed against the lands in "Class A," seven mills per acre shall be assessed against the lands in "Class B," six mills per acre shall be assessed against the lands in "Class C," five mills per acre in "Class D," four mills per acre in "Class E," three mills per acre in "Class F," two mills per acre in "Class G," and one mill per acre in "Class H." This scale shall form the basis of assessment of benefits to lands for drainage purposes. If, in the judgment of the engineer and viewers, it is not necessary to separate the lands in the district into eight classes, they may separate same into a less number of classes, and the scale of assessments for benefits shall be changed accordingly.

Section 3. The boundaries of lands as surveyed and mapped, the ownership thereof, and the classification and assessment thereof, as appears in the final report and map and upon the assessment roll, shall be and remain as of the time when the district was established and the final report of the Board of Viewers was approved by the court. No conveyance or devise of land or devolution by inheritance after the petition has been filed or the owner thereof has been served with the original summons, either by personal service or by publication, shall affect the status or liability of such land as a part of such drainage district, except as herein provided.

If the owner or owners of any lands included in such district shall, after the filing of the petition and after being served with the original summons and before the approval of the final report, convey the whole or any part of such lands, or the title thereto shall be otherwise changed, then and in such event the grantor and grantee or new owner or either may file a petition in an ancillary proceeding before the clerk of the Superior Court setting forth the facts, with a description of the lands conveyed either in part or the entire body of land, together with a description of the land excepted and not conveyed. If the grantor or grantee or new owner, in whole or in part, file such petition, the other not so joining shall be served with notice of same. The clerk may require the petitioner to attach to the petition a map showing the boundaries of the entire body of land as it appears in the record of the proceeding, and also showing the part conveyed. If the ownership of such land has been changed by devise or inheritance, or any joint ownership has been changed by partition, such new owners may file a petition as herein provided. Such petition shall conclude with a prayer that the grantee or new owners be made a party to the proceeding. The court after a hearing may make the grantee or new owner a party to the drainage proceeding, and shall certify to the engineer and viewers a description of the land so conveyed or held by the new owner or owners, with directions to verify the boundaries and to classify the said land, to the same extent as if the grantee was the original party. Any part of such lands not so conveyed shall be and remain a part of the district.

After the district shall be established, the lands classified, the final report approved and the assessment roll filed, no conveyance of any land in the district shall affect or change the existing status or liability of such lands as to assessment charges or otherwise, except in the manner herein defined.

Where the title and ownership of any tract or tracts of land embraced in the district have been changed or vested in another or others by grant, devise, or inheritance, or by partition between joint owners, subsequent to the estab-

lishment of the district, the assessment roll may be amended in the following manner. The grantor and grantee, or the new owner or owners, may file a petition with the Chairman of the Board of Drainage Commissioners alleging that the ownership of the land has changed, and the manner thereof in whole or in part. If the whole body of land, as appears in the final report or on the assessment roll, has changed ownership, a general description consistent with such final report and map shall be sufficient. If the ownership of the body of land has changed only as to part thereof, the petition shall contain a description of the part thereof claimed by the new owners, and the number of acres and the classification or the several classes if it be in more than one class, and also a description of that part of the land the title to which remains in the original owner, with the number of acres and with the classification and the several classes if it contains more than one class of land. The petition shall so describe the land and the number of acres in each class as to that part of which the ownership has changed as to maintain the number of acres originally assessed and the class or classes in which the same has been assessed, and the Chairman of the Board of Drainage Commissioners may require the petitioners to have the said lands surveyed and submit a map if the same shall be necessary. The Chairman of the Board of Drainage Commissioners shall present this petition to the Clerk of the Superior Court at any time thereafter, not later than the first Monday in July following. It shall be the duty of the clerk to examine and verify the facts set forth in the petition, and particularly if the number of acres assessed and the classes thereof against the new owners added to the number of acres and the classes assessed against that part of the land, the title to which has not changed, shall equal the total number of acres and the classes so assessed as appears against such entire body of land in the original petition. If the clerk shall be so satisfied, he shall enter up an order or decree changing the original assessment roll, or the assessment roll as theretofore amended, by adding the name of the new owner with the number of acres assessed in each class, and by amending the number of acres assessed and the classes thereof against the original owner, as appears on the original assessment roll or assessment roll as theretofore amended. It shall be the duty of the clerk after such order to make such changes in the assessment roll. It shall be the duty of the clerk of the Superior Court in making changes in the original assessment roll from time to time to observe and maintain the total number of acres in each class, to the end that the revenue produced from the annual assessment shall not be thereby diminished. The Chairman of the Board of Drainage Commissioners, instead of presenting to the clerk of the court each petition of landowners separately, may combine a number of petitions and present the same to the court at one and the same time. The first Monday in July in each year is hereby set apart as a special day on which petitions for changing the assessment roll may be submitted, at which time the clerk shall hear all petitions not theretofore submitted. If the Chairman of the Board of Drainage Commissioners shall fail to act when any petition shall be submitted to him as herein provided, or to discharge any duty imposed by this section or any other provision of the General Drainage Law, it is hereby made the duty of the clerk of the Superior Court, either independently or upon the request of any landowner in the district, to cite the said Chairman to appear before him upon a certain day and show cause why he should not be removed from office, and unless good cause be shown, it shall be the

duty of the clerk to remove the Chairman of the Board of Drainage Commissioners and to certify his action, to the end that another chairman may be elected according to law. If the failure of the Chairman of the Board of Drainage Commissioners to discharge such duty shall be willful, he shall be guilty of a misdemeanor and upon conviction shall be punished by fine or imprisonment, or both in the discretion of the court.

If the grantor and grantee, or all those claiming to have acquired title to any body of land on the assessment roll and whose assessment will be affected, cannot agree upon joinder in a petition to the Chairman of the Board of Drainage Commissioners, or if the said Chairman fails within a reasonable time to discharge his duty by presenting the petition to the court, then either party interested in the tract of land as it appears on the assessment roll may file a petition with the clerk of the Superior Court setting forth the facts as to the change in ownership and title of such land, with the description of the entire tract of land and the number of acres in each class, together with a description of that part of the land as to which the ownership has changed, with the number of acres in each class, and pray the court to order that the assessment roll be amended in accordance with the title and interest of the several owners. At the time of filing the petition a summons shall issue to the other parties interested in the said tract of land to show cause on a day certain why the prayer of the petition should not be granted. Upon the return day the clerk of the court shall hear all the evidence, find the facts, and enter up judgment, directing the appropriate amendment to the assessment roll. It shall be the duty of the clerk to amend the assessment roll in accordance with his judgment. No judgment or amendment of the assessment roll shall be valid unless the number of acres and the classes assessed against the new owners shall equal the area and classification as contained in the tract of land as it appears on the original assessment roll. This petition may be presented to the court at any time, but the first Monday in July in each year is hereby designated as the day upon which all petitions for amendments to the assessment roll may be submitted. Any amendments to the assessment roll ordered after the last day of August in each year shall not become effective until the first day of September the following year, and the assessment roll as it appears on the first day of September of each year shall constitute the assessment roll to be delivered to the sheriff on the first Monday in September; and he shall collect the drainage assessments as they appear thereon, without regard to any changes in title or ownership or any changes in the assessment roll made by the court, after the 31st day of August. All amendments sought to be made to the assessment roll shall have reference to the assessment roll as it appears at the time the amendment is sought, which shall be either the original assessment roll or as amended, but it shall be the duty of the clerk of the Superior Court to examine frequently the assessment roll as amended and before the same shall be further amended, and make certain that the aggregate number of acres in each class as appeared on the original assessment roll shall not be reduced nor the aggregate annual assessments reduced. Any amendments ordered shall be made on the assessment roll and become due in the following September, and on all subsequent assessment rolls which have not become due or collectible. It shall be the duty of the Chairman and the Secretary of the Board of Drainage Commissioners of the district to render to the clerk of the court any clerical assistance involved in changes in the assessment

rolls, but the primary duty and responsibility in making such amendments shall remain with the clerk of the Superior Court, and he shall be held liable for any error or omissions which may work a loss to the district or the bondholders. If such amendments to the assessment rolls shall make necessary the preparation of new assessment rolls, the clerk of the Superior Court shall be required to prepare such new assessment rolls with the clerical assistance of the Chairman and Secretary of the Board of Drainage Commissioners, and such new assessment rolls shall be signed by the Chairman and Secretary of the Board of Drainage Commissioners and the clerk of the Superior Court before delivery to the sheriff or tax collector, as required upon the original assessment rolls. The original assessment rolls shall be preserved by the clerk of the court among his records for future reference. Any costs which may accrue in amendments to the assessment rolls shall be adjudged against the parties in interest in the discretion of the clerk, and such costs shall be paid before the amendment shall become effective. As to all petitions which shall be filed and submitted to the court on the first Monday in July, no costs shall be paid or adjudged against any party in those counties where the clerk and sheriff receive a salary in lieu of fees. As to all petitions filed with the Chairman of the Board of Drainage Commissioners or as to the discharge of any duty by the Chairman required of him under the general drainage law, he shall be presumed to act for the Board, and the Chairman shall do all things necessary to protect and maintain the interests of the drainage district. If the Chairman shall be or become a landowner in the drainage district and may desire an amendment to the assessment rolls, he may file his petition before any other member of the Board, or file the same directly with the clerk of the Superior Court. The provisions of this section shall apply to landowners in districts heretofore established, also to drainage proceedings heretofore instituted, to the same extent as to drainage proceedings hereafter instituted and established.

Section 4. That section 19 of chapter 442, Public Laws of 1909, be amended by adding to said section the following: That in the election of drainage commissioners by the owners of land, each landowner shall be entitled to cast the number of votes equalling the number of acres of all land owned by him and benefited, as appears by the final report of the viewers. Each landowner may vote for the names of three persons for commissioners. If any person or persons in any district shall own land in any district containing an area greater than one-half of the total area in the district, such owner shall only be permitted to elect two of the drainage commissioners, and a separate election shall be held under the direction of the clerk by the minority landowners, who shall elect one member of the Drainage Commissioners. Immediately after the election of said Board of Drainage Commissioners, and after the members of the said Board shall be appointed by the clerk, the clerk of the court shall notify each of them in writing to appear at a certain time and place within the county and organize. The clerk of the Superior Court shall appoint one of the three members as Chairman of the Board of Drainage Commissioners, and in doing so he shall consider carefully and impartially the respective qualifications of each of the members for this position. The term of service of the members of the Board of Drainage Commissioners so elected and appointed shall begin immediately after their organization, and they shall serve further for a term of four years beginning on the first day

of October following their organization. In the year when their term shall expire, the clerk of the court shall provide for an election of their successors to be held on the second Monday in August preceding the expiration of their term on the 30th day of September. The clerk of the court shall record in the drainage record the date of election, the members elected, and the beginning and expiration of their term of office. If a vacancy shall occur in the office of any commissioner by death, resignation, or otherwise, the remaining two members are to discharge the necessary duties of the Board until the vacancy shall be filled, and if the vacancy shall be in the office of Chairman or Secretary, the two remaining members may elect a Secretary, and the clerk shall appoint one of the two remaining members to act as Chairman, to hold until the vacancy in the Board shall be filled. The clerk shall keep a similar record of any election to fill vacancies, and the member or members shall be elected in like manner as the original members, and shall serve until the expiration of the term of his predecessor. The Secretary of the Board of Drainage Commissioners shall promptly notify the clerk of the Superior Court of any vacancy in the Board. If for any reason the clerk of the court shall fail to provide for an election of Drainage Commissioners on the second Monday in August to succeed those whose terms will expire on the 30th day of September, the said clerk shall have authority at the most convenient date thereafter to provide for such election, and in the meantime the incumbents shall continue to hold their office as commissioners until their successors are elected and qualify.

The term of office of Boards of Drainage Commissioners heretofore elected and appointed shall expire on the 30th day of September, 1917, and their successors shall be elected on the 2d Monday in August, 1917, in the manner provided by law.

The Chairman of the Board of Drainage Commissioners shall receive compensation based on an annual payment of $50 per annum in districts containing less than 5,000 acres in the aggregate, but the clerk of the Superior Court shall be authorized to increase this annual compensation to $100 if the duties required of the Chairman shall appear to justify such increase. In addition the Chairman shall receive his actual and necessary expenses of travel and subsistence for which he shall file an itemized statement of the amounts actually expended. The remaining two members of the Board shall receive a compensation of $3 per day while necessarily engaged in attendance upon meetings of the Board or in the discharge of other necessary duties imposed by the Board, and in addition shall receive their actual and necessary expenses in attending meetings of the Board. The Secretary of the Board, if other than a member of the Board, shall receive such compensation for work actually performed as may be determined by the Board. In drainage districts of unusually large area and requiring greater time and attention, the Chairman of the Board may be paid a greater compensation than $100 per annum to be allowed by the clerk of the Superior Court, based on a petition filed by the Board with the clerk, setting forth all the facts necessary for a determination of the matter. All such payments allowed to the Chairman and members of the Board shall be paid by vouchers upon the Treasurer of the district issued in proper form.

Section 5. That section 25 of chapter 442 of the Public Laws of 1909, as amended by section 6 of chapter 67 of the Public Laws of 1911, be further amended by adding thereto the following: That where any public canal

established under the provisions of the General Drainage Law shall intersect any private road or cartway the actual cost of constructing a bridge across said canal at such intersection shall be paid for from the funds of the drainage district and constructed under the supervision of the Board of Drainage Commissioners, but the said bridge shall thereafter be maintained by and at the expense of the owners of the land exercising the use and control of said private road: *Provided*, if the said private road shall be converted into a public highway, the maintenance of said bridge shall devolve upon the board of commissioners of the county or by such other authority as by law shall be required to maintain public highways and bridges.

Section 6. That section one thousand seven hundred and ninety-two (1792) of the Revisal of North Carolina, which recites the classes of investments in which guardians, trustees, and others may invest their surplus funds, shall be amended by adding after the words "North Carolina," in line five, the following words: "or in drainage bonds duly issued under the provisions of chapter 442 of the Public Laws of 1909"; and that said section shall be further amended by adding after the words "North Carolina" and before the words "shall be," in line eight, the following words: "and such drainage bonds."

That the State Treasurer is authorized to receive drainage bonds issued by drainage districts in North Carolina as deposits from banks, insurance companies, and other corporations required by law to make deposits with the State Treasurer: *Provided*, that the Attorney-General shall have approved the form of said bonds.

Section 7. That sub-districts may be formed by owners of land in main districts theretofore established for the purpose of securing local or tile drainage, in the manner provided by chapter 442, Public Laws of 1909, and acts amendatory thereto, for the organization of main districts. Such sub-districts shall have the right to use the ditches or canals of the main districts for outlets. The formation of sub-districts shall not operate to release the lands in any sub-district from the payment of any assessment or levy made prior to the formation of such sub-districts, nor from any assessment which may thereafter be made for the completion and maintenance of the canals in main districts, or for the payment of the principal and interest on any indebtedness incurred by the main district, nor shall it give the sub-district any claim on the funds of such main district for its local use.

It shall be the duty of the Drainage Commissioners of the main district to control all matters pertaining to the main district drainage. Drainage Commissioners for the sub-districts shall have authority and control over all matters pertaining to drainage within their respective sub-districts, except such work as belongs exclusively to the main district.

Section 8. The treasurer of the county and *ex officio* treasurer of the district shall deposit any surplus funds belonging to any drainage district in local banks in the county, and preferably in banks located nearest the said drainage district: *Provided*, the said treasurer shall be satisfied as to the solvency of such bank or banks; and *Provided further*, that nothing contained in this section shall release the treasurer or the sureties on his bond from any loss accruing by reason of the insolvency of any bank or banks where such funds may be deposited. If the treasurer of the district shall deposit any funds belonging to the district in any bank he shall require the payment of the usual rate of interest paid by such bank upon time deposits.

SECTION 9. That section 12 of chapter 67 of the Public Laws of 1911 be amended by adding thereto the following: That if, for any reason, the sheriff or tax collector shall fail to advertise and make sale of lands of delinquents on the first Monday of February or on the first Monday of March as above provided, then, and in such event, the said sheriff or tax collector shall advertise and make sale of any lands upon which the assessments shall remain unpaid on the first Monday in April succeeding, and if for any reason he shall fail to advertise and make sale on the first Monday in April, then he shall advertise and make sale of the lands of delinquents on the first Monday in May succeeding.

If any sheriff or tax collector shall fail to comply with the law for the collection of drainage assessments, or in making payments to the Treasurer as provided by law, he shall be guilty of a misdemeanor, and upon conviction shall be subject to a fine and imprisonment, in the discretion of the court, and he shall likewise be liable in a civil action for all damages which may accrue either to the board of drainage commissioners or to the holder of said bonds, to either or both of which a right of action is given.

That, in addition to the two copies of the assessment rolls as provided in the section to which this is amendatory, a third copy of the several assessment rolls shall be prepared and filed with the chairman of the Board of Drainage Commissioners, who shall carefully preserve the same.

If any sheriff or tax collector was authorized to collect drainage assessments in any year prior to the approval of this act, and failed to collect any part of such drainage assessments, and is now out of office or is still holding the office of sheriff or tax collector, then and in such event such sheriff or tax collector, regardless of the expiration of his term of office, is hereby authorized and directed to proceed in the collection of such unpaid drainage assessments, and in default of payments being made, he is further authorized to make sales of such lands as may be in default at the times and in the manner authorized by law during the years 1917-1918 or 1919.

The sheriff or tax collector shall be required to make settlements with the county treasurer on the first day of each month of all collections of drainage assessments for the preceding month, for which the treasurer shall execute appropriate receipt. The clerk of the Superior Court in each county where one or more drainage districts shall have been established shall be required to have prepared a form of receipt with appropriate stubs attached for the drainage assessment due on each tract of land as recited in the assessment rolls. This bound book of tax bills or receipts shall be endorsed "Drainage assessments of the (here give the name of the district) for the county of ....., delivered to the sheriff or tax collector as of the first Monday in September, 19..., for collection as required by law," and the same endorsement shall be printed at the top of each tax bill or blank receipt. Each tax bill or blank receipt shall contain a blank space for the name of the owner of the property, the amount of the annual drainage tax, the amount of maintenance tax, if any, and a receipt at the bottom of same followed by a blank line for the signature of the tax collector. This bound book of tax bills or receipts with the blank duly filled in shall be delivered to the sheriff or tax collector on the first Monday of September of each year. The necessary cost of printing and binding of such book of tax bills or receipts and the filling in of same shall be a proper charge against the county, and shall be paid by the Board of County Commissioners.

SECTION 10. On the first Monday in May, 1917, the Board of County Commissioners of each county in which one or more drainage districts shall have been established, and annually thereafter, shall appoint an intelligent and competent person of sufficient experience who shall be designated as "auditor for drainage districts." Such auditor will be required to examine the assessment roll and the records and accounts of the sheriff or tax collector as to the assessment roll which went into his hands on the previous first Monday in September, and for all previous years as to which the records and accounts of the sheriff or tax collector have not been audited. Such auditor shall for each of such years make a report as to each drainage district showing the total amount of drainage assessments due for each year, the amount collected by the sheriff up to the 15th day of May of the following year, the names of the owners of land, and a brief description of the lands on which the drainage assessments have not been paid, and the total amount of unpaid drainage assessments, with any further data or information which the auditor may regard as pertinent. If lands in the district lie in another county or counties, then such auditor for the county in which the district was established shall also examine the records of the sheriff or tax collector in such other counties. Such auditor shall also examine the books of the treasurer of the county for similar years, and he shall report the amount of drainage assessments paid to the treasurer by the sheriff or tax collector for each year, and the amounts paid out by the treasurer during such years and for what purposes paid. It shall be the duty of the sheriff and treasurer to permit the auditor to examine his official books and records and to furnish all necessary information, and to assist the auditor in the discharge of his duties. Such auditor shall make a report to the Board of County Commissioners on or before the first Monday in July following his appointment, and he shall deliver a duplicate of such report to the Chairman of the Board of Drainage Commissioners of each drainage district established in the county. If the sheriff shall not have collected all of the drainage assessments or shall not have paid over all collections to the county treasurer, or if the treasurer shall not have made disbursements of the drainage funds as required by law, or has not in his hands the funds not so disbursed by him, it shall be the duty of such auditor to prepare two certified copies of his report, one of which shall be delivered to the judge holding a term of Superior Court in the county following the first Monday in July, and a copy to the solicitor of the judicial district in which the county is located, and it shall be the duty of such solicitor to carefully examine such report and to institute such action, civil or criminal, against the sheriff or tax collector or the treasurer as the facts contained in the report may justify or as may be required by law.

SECTION 11. Where any drainage district which has been established contains lands located in a county or counties other than the county in which the district was established, the clerk of the Superior Court of the county in which the district was established shall have prepared a form of tax bills or receipts, with appropriate stubs attached, covering all the lands in the drainage district located in such other county or counties, and in the form herein provided for the county in which the district has been established,

and have the same substantially bound in book form. He shall also fill in the blanks of such tax receipts ready for the signature of the tax collector. On a page in such bound book, after the tax bills or receipts, there shall be appended an order directed to the sheriff or tax collector in the county in which such lands are located, which shall be in substantially the following form:

State of North Carolina,
County of .....
The Sheriff or Tax Collector of ..... County:

This is to certify that the foregoing tax bills or blank receipts embrace the drainage assessments made on certain lands in the county of ....., which are located in and are a part of (here insert the name of the drainage district) which district was established in the county of ..... These assessments are due on the first Monday of September, 19..., and must be paid and collected within the time required by law. You will make monthly settlements of your collections with the Treasurer of ..... County, being the county in which the district was established, and in all other respects you will discharge your duties as sheriff or tax collector as required by law.

In witness whereof, I have hereunto set my hand and official seal, this ..... day of ....., 19....

.....,
Clerk Superior Court of ..... County.

Thereupon such drainage assessments in such county shall have the force and effect of a judgment upon the lands so assessed as in the case of State and county taxes, and shall in all other respects be as valid assessments as those levied upon lands in the county in which the district was established. The auditor for drainage districts herein authorized shall also examine the records and accounts of the sheriff of such county. In the establishment and administration of the drainage districts, the clerk of the Superior Court, the county treasurer and the Chairman of the Board of Drainage Commissioners shall have jurisdiction over the lands and the collection of drainage assessments in the county or counties other than the county in which the district was established to the same extent as in the county where such district was established.

Section 12. Any lands not included in any drainage district which may be established but which are located contiguous to or near the boundaries of such drainage district, and the drainage of which may only be secured by utilizing the outlet canal or canals of such drainage district, may be included in such drainage district by either one of the following methods:

1. The owners of such lands may file a petition with the court setting forth the facts and praying to be included in the drainage district, and at the same time a summons shall be issued directed to the Chairman of the Board of Drainage Commissioners to show cause why the prayer of the petitioners shall not be granted. In determining the issue the clerk shall consider all the facts, and the procedure for the establishment of drainage districts shall be followed so far as the same may be applicable.

2. Or the Chairman of the Board of Drainage Commissioners, having been so directed by the Board, may file a like petition setting forth the facts and praying that the land or lands may be included in the drainage district, and

a like summons shall issue against the owners of the lands. Substantially the same procedure shall be followed as far as applicable. If the prayer of the petitioners shall be granted, and the courts shall make an order directing that the said lands be included within the drainage district, the boundaries of the drainage district shall be re-formed accordingly, and the assessment roll shall be amended so as to include the said lands with the number of acres and classes and the assessment against each tract of land, such amendment to the assessment shall be made by the clerk of the Superior Court.

Section 13. That chapter 238 of the Public Laws of 1915 and section 11 of chapter 442 of the Public Laws of 1909 be, and the same are, hereby repealed, and in lieu of said section 11 the following section shall be substituted:

That it shall be the further duty of the engineer and viewers to assess the damages claimed by owners of any land for land actually taken and used as a right of way for the construction of any canal or any other purpose necessary in the execution of the drainage plans, which shall include damage to growing crops or to the timber located upon the lands so taken, or for any other injury necessarily incident to the taking of land for the construction of the drainage improvements. Such damage shall be considered separate and apart from any benefit the land would receive because of the proposed improvements, and such damages shall be paid by the Board of Drainage Commissioners to such persons entitled thereto as a part of the costs of the improvement.

Section 14. That this act shall not apply as to any order which has been made in any pending drainage proceeding entered before the approval of this act, and shall only apply to subsequent stages of any pending drainage proceeding to the extent that this law is consistent therewith and will further the purpose thereof. That all laws in conflict with this act are hereby repealed.

Section 15. That this act shall be in effect from and after its ratification.

FISHING INDUSTRIES

For a series of years the Survey, in coöperation with various Federal bureaus, has undertaken to study conditions governing our commercial fisheries, and to ascertain remedies for the adverse conditions which appear to have been operating to the destruction of this great natural resource. Through a series of investigations, the fact seemed to be established that the growing scarcity of fish was due in the main to overfishing, and that the remedy lay in some form of State restriction which would give the fish a chance to enter their spawning grounds at the proper season, and prevent the marketing of fish under a certain size.

It has also been ascertained through a series of experiments that certain shellfish, such as the oyster, clam, diamond-back terrapin, etc., can be economically cultivated in North Carolina waters; and that there are possibilities for great industries growing from the establishment of this fact.

Believing that the State should interfere to protect this great natural resource for the benefit of all people, and that it would be to the best interests of the State to foster industries capable of producing a great

food supply and source of revenue to the State, the Survey has steadfastly advocated for a long time the establishment of a State Fisheries Commission, which would have jurisdiction over all the waters of the State. Legislation to this effect has been advocated by the Survey for a number of years, but it remained for the Legislature of 1915 to establish a Commission with State-wide jurisdiction. Before the State-wide Fisheries Commission was established, the Survey audited and approved the accounts of the Fish Commission and coöperated with it in marking out restricted areas, etc.

Since the establishment of the North Carolina Fisheries Commission the State Geologist has been relieved of a great deal of the work in connection with this industry. He has, however, assisted in every way possible this Commission, and he took an active part in bringing to Wilmington, N. C., the annual meeting of the National Association of Fisheries Commissioners. The State Geologist also assisted largely in arranging for the convention, which was held April 18 to 20, 1916. The State Geologist was also instrumental in bringing Hon. William Redfield, Secretary of Commerce, to the Convention. The State Geologist presided at the first meeting of the convention and made an address on "Fishery Legislation." The United States Bureau of Fisheries has assisted the State Survey and the Fisheries Commission in every way possible to make the work of the Commission a success. During the past two years the United States Bureau of Fisheries has done work in North Carolina as described below:

WORK OF THE UNITED STATES BUREAU OF FISHERIES IN NORTH CAROLINA DURING THE CALENDAR YEARS 1915 AND 1916

In January, 1915, Dr. H. F. Moore, of the Bureau of Fisheries, by invitation of the State authorities, addressed the Legislature in Raleigh on the "Conservation of the Fisheries of the State." This visit of Dr. Moore was occasioned by the fact that a bill embodying comprehensive provisions for the regulation and development of the fishery was then receiving consideration. The law was passed in culmination of an effort in which the Bureau had coöperated with the State officials during a period of some ten years.

After the Fisheries Board and the Fish Commissioner had been appointed and preliminary meetings held, a meeting was called in Morehead City, the last part of June, 1915, for the adoption of a plan of procedure and proper regulations. In response to a request from the Board, the United States Bureau of Fisheries was represented in this conference by Dr. R. E. Coker, Assistant in Charge of Scientific Inquiry.

In April, 1916, while the meetings of the National Association of Fisheries Commissioners were being held in Wilmington, addresses were delivered both by Hon. William C. Redfield, Secretary of Commerce, and Dr. H. F. Moore, Deputy Commissioner of Fisheries. At the same time Dr. Moore visited several points in Eastern North Carolina for the purpose of inspection of stations and observation of fishery apparatus.

The laboratory of the Bureau of Fisheries at Beaufort, N. C., has been in active operation during the two years under consideration, and especially during the summer season, when a considerable number of scientific specialists are engaged in research more or less directly related to the fishery problems of the State and of the South Atlantic Coast. The steamer, *Fish Hawk,* was engaged at Beaufort in surveys of fishing grounds during a portion of the summer of 1915. The direction of the investigations and experimental work at Beaufort occasioned visits both in 1915 and in 1916, by Dr. R. E. Coker, Assistant in Charge of the Division of Scientific Inquiry. An account of the investigations and a summary of the principal results secured are contained in the Annual Reports of the Commissioner of Fisheries. Special attention may be called to the increasingly encouraging success of the experiments in diamond-back terrapin culture and to the apparently permanent establishment of a sea fishery for blackfish (sea bass) on offshore grounds surveyed by the Bureau of Fisheries. The Bureau renders a substantial aid to the fishermen by maintaining a buoy on the principal fishing grounds, which serves not only as a means of locating that particular ground, but also as a point from which to take bearings or to make a course for other and smaller grounds. The local fishery interests have not yet availed themselves of the opportunities in offshore fishery to the fullest extent practicable and desirable.

Various special investigations have been conducted in the State.

January 4-10, 1916, Dr. W. C. Kendall, assistant in the Bureau of Fisheries, made an examination of the Lumbee River and other waters in the vicinity of Pine Bluff, N. C., for the purpose of ascertaining the possibility of establishing the rainbow trout in such waters. A comprehensive investigation of the habits and migrations of the shad pursued during the year 1916, has been conducted in part in the State of North Carolina. A broad study of the habits of the blue crab, with reference to its proper conservation is being conducted primarily in the Chesapeake Bay, but the investigation is also extended into North Carolina, especially in the vicinity of Beaufort.

The alleged pollution of the Roanoke River by pulp mills in the vicinity of Weldon has been a matter of much concern to the fishermen, especially to those engaged in the capture of shad and striped bass (or

rock fish). A careful investigation of the matter by the Bureau of Fisheries revealed the fact that there were existing abuses which could be remedied. While the Federal Bureau had no jurisdiction in the matter, they promptly brought the facts to the attention of the owners of the plant discharging the injurious pollutant into the river. At the same time they sought and secured the coöperation of the company in removing any possible sources of complaint. Steps are now being taken in an active and satisfactory manner to evolve a plan of handling the affluent so as to prevent the discharge of any deleterious matters into the river. Some experimentation may be required to bring about an entirely satisfactory result, but, with the continued active interest of the company and the advice of the specialists in the service of the Bureau of Fisheries, the desired end will probably be attained.

During September and October, 1916, the Bureau conducted a biological and fish cultural survey of the waters of a large preserve near Linville, N. C., and of the Pisgah National Forest Reserve near Asheville. Much information was gained that will be of assistance in future fish cultural operations in the State, but a final report will not be issued until a further examination can be made during the late spring, when the conditions for the development of the fish fry can be investigated.

From November 26 to December 19, 1916, the United States Fisheries Schooner *Grampus* was engaged in a survey of the fishing grounds off the mouth of the Cape Fear River, with the coöperation of the North Carolina Fisheries Board and the City of Wilmington. It was planned to extend the survey to the exploration of possible shellfish resources, but owing to inclement weather conditions prevailing and the limited time available, this part of the original plan could not be carried out. Several important fishing grounds were explored and charted.

At the annual meeting of the American Fisheries Society held in New Orleans, October 16, 1916, the State Geologist presented a paper on The Fisheries of North Carolina, and this is given below:

THE FISHERIES OF NORTH CAROLINA

By Joseph Hyde Pratt

A new era was started in the development of the fishing industries of the State of North Carolina when the General Assembly of the State passed on March 4, 1915, "An act to establish a Fisheries Commission and to protect the fisheries of North Carolina."*

This law, which is State-wide, is considered by nearly all who have investigated it to be the most efficient and best fishery law that has been passed by any State. Honorable William C. Redfield, Secretary of

*Public Laws of North Carolina, chapter 84, Session 1915.

Commerce, in an address before the annual meeting of the National Association of Fisheries Commissioners on April 18, 1916, at Wilmington, North Carolina, said:

"I have taken no little pride, gentlemen of North Carolina, in pointing out personally to the Governors of other States and to the legislators of other States the progressive and effective law that exists here, a good law which has put the State of North Carolina in advance of others to its own good and to its great honor. I know that it has had a marked effect upon opinion elsewhere, that it has put the State of North Carolina in a position of prestige and dignity and self-respect and of vision for the future, and of common sense as regards the children that are to come, which has made it honorable in the sisterhood of States in this country. The State of North Carolina has led the way in this respect and others have shown it the flattery of imitation."

It is believed that this law will enable the State to build up its fishing industry to a point where it can be compared favorably with a similar industry in any other State.

The passage of this law was only brought about by a campaign of education throughout the whole State; in which the people of the western and central portions of the State were informed as to the value of the fisheries, what they should mean to the State, and that they belong just as much to the people of the west as to those of the east. Many subjects appertaining to the fisheries of the State were discussed at various meetings in different parts of the State, and pamphlets and newspaper sketches were printed upon these same subjects. Among the most startling points that were brought to the attention of the people regarding the fisheries were:

1. That North Carolina instead of being first in the output of her fisheries as is warranted by the abundance of her inland waters, which are peculiarly adapted for the maintenance of commercial fisheries, now holds eleventh place among the Atlantic and Gulf States.

2. That the ascendency of these other States, particularly Virginia, Maryland, Connecticut, and Louisiana, has been obtained entirely through the enforcement of such regulations as would allow a reasonable catch from their fisheries and would preserve a sufficient part of the fish, so that the supply of each succeeding year would steadily increase instead of diminish.

3. That the decrease in the North Carolina fisheries is undoubtedly due to very heavy fishing of all kinds of apparatus, and the violation of the laws that have been passed to regulate fishing. This applies to both fin fish and shell fish.

4. That the most noticeable decrease in North Carolina fin fish has been among her more valuable fish, such as shad and herring.

5. That the oyster industry of North Carolina was at such a low ebb that it was hardly considered in the discussion of the oyster industry of this country.

6. That instead of the fish industry being worth from $7,000,000 to $8,000,000 per year, it is worth less than $2,000,000 per year.

7. That instead of North Carolina supplying her home demand of fish and oysters she is obliged at the present time to obtain a considerable proportion of them from other States.

8. That the fisheries of North Carolina belong to the whole State, and that the citizens of the State at large should be interested in their preservation and perpetuation.

The people, when they realized the condition of the fisheries and that they do belong to the State as a whole, took up seriously the question of how to protect and conserve this valuable asset of the State. As this was largely a question of legislation, it was pointed out:

First. That the legislation must provide for an impartial, uniform and efficient enforcement throughout all sections of the State, in the interest of all the people of the State and not to the temporary interest of the fisherman.

Second. That the enactment of rules and regulations governing the fisheries must be such that they will give the greatest liberty to the fishermen consistent with the development and conservation of the fish industry.

Third. That the closest and most cordial coöperartion should exist between the State Commission and the Federal Bureaus, particularly in the planting of fish and oysters.

Fourth. That in the administration of the laws and regulations governing the utilization of the fisheries a great deal of consideration must be given to the opinions and supposed rights of the fishermen, but that when the commission had, after due deliberation, passed certain regulations, these must be enforced impartially.

On account of the varied conditions that exist in all fishing localities there must be considerable elasticity in the law. The commission should have the power to regulate. The recently passed North Carolina laws, are superior to those of other States in this question of elasticity. In support of this I would quote section 21 of the law, which is as follows:

SECTION 21. The Fisheries Commission Board is hereby authorized to regulate, prohibit, or restrict, in time, place, character, and dimensions, the use of nets, appliances, apparatus, or means employed in taking or killing fish; to regulate the seasons at which the various species of fish may be taken in the several waters of the State, and to prescribe the minimum sizes of fish which may be taken in the said waters of the State; and such regulations, prohibition, restrictions, and proscriptions, after due publication, shall be of equal force and effect with the provisions of this act; and any person vio-

lating the provisions of this section shall be guilty of a misdemeanor, and upon conviction shall be fined or imprisoned at the discretion of the court: *Provided, however*, that if a petition signed by five or more voters of the district or community which will be affected by the proposed change if filed with the Fisheries Commission Board through the Fisheries Commission, assistant commissioners, or inspectors, asking that they have a hearing before any proposed change in the territory, size of mesh, length of net, or time of fishing shall go into effect, petitioning that they be heard regarding said change, the Fisheries Commission Board shall in that event designate, by advertisement for a period of thirty days, at the courthouse and three other public places in the county affected, and also by publication in a newspaper of the county, if such is published in said county, for two consecutive weeks, the place at which said board shall meet and hear argument for and against said changes, and may ratify, rescind, or alter this previous order of change as may seem just in the premises; and *Provided further*, that in making regulations the Fisheries Commission Board shall give due weight and consideration to all factors which will affect the value of the present investment in the fisheries, and that no changes in the existing laws which, if they should go into effect immediately, would tend to cause fishermen to lose their property shall go into effect until twelve months from the date that the change has been made by the Fisheries Commission Board.

While the North Carolina law has only been in operation a little over a year, yet we are beginning to realize that it was a very valuable piece of constructive legislation that the General Assembly of 1915 passed, and that splendid results are to be obtained under it. While it does delegate to a central body the control of the fisheries of the State, it is, in my judgment, the only way by which our fisheries can be conserved and increased. Previous local control has nearly wiped out the sturgeon industry of North Carolina and other states; it has greatly decreased the mullet industry by reason of the catching of undersized mullets; was rapidly depleting the striped bass and black bass fisheries; and it has nearly destroyed the oyster industry in this State and in others. On the other hand where there has been a central control of fisheries there has been a general restoration of certain fisheries that had been nearly depleted.

In 1907 North Carolina, according to Dr. Hugh M. Smith,* was far advanced in all phases of the fisheries among the South Atlantic States, and the State exceeded all the others combined as regards the number engaged in fishing, the amount of capital invested, and the quantity and value of the annual yield. This is the prestige that North Carolina formerly had, and we believe that the operation of the present law will bring this back to her. There are but few other states that have as large a population so entirely dependent on the water for a livelihood as North Carolina.

*North Carolina Geological and Economic Survey, Volume II, page 407; 1907.

The fish fauna of North Carolina is very rich in both species and individuals, and this is due to its great variety of topography and its large shallow sounds along the coast. It is stated by Dr. Hugh M. Smith, United States Commissioner of Fisheries,* that among the prominent features of the fish fauna are:

(a) The abundance of certain anadromous fishes, whose numbers are scarcely surpassed in any other waters, the chief of these being the shad, the alewives, and the striped bass.

(b) The variety and abundance of suckers, minnows, and sunfishes in the fresh waters generally and of darters in the headwaters of the streams on both sides of the Alleghanies.

(c) The occurrence in the sounds and along the outer shores of immense schools of mullet, squeteague, menhaden, blue-fish, croaker, spot, pig-fish, pin-fish, and other food fishes.

(d) The extension to the North Carolina coast of many species which are characteristic of the West Indies or Florida.

(e) A few species of the Atlantic coast reach their southern limit in North Carolina (such as the cod and tautog) or do not occur in noteworthy numbers further south (such as the white perch and striped bass).

Of the 352 species of fish recorded from North Carolina, about 95 at present have commercial value. To these would be added oysters, clams, mollusks, scallops, crabs, shrimps, turtles, and frogs, which would represent the fisheries of the State.

North Carolina has been noted particularly for its production of black bass, shad, alewives, hickory shad, striped bass, white perch, eel, sturgeon, mullets, squeteagues, croaker, spot, Spanish mackerel, and menhaden.

There is given below a list of the commercial fishes, together with localities from which they are obtained:

Sturgeon. *Acipenser oxrhynchus.*

This species has been almost exterminated in the waters of North Carolina, where formerly it was very abundant. It is probable that by radical measures to prevent further diminution in the supply of this fish, that it can be restored to something like its original abundance. Dare County now produces the greater bulk of the sturgeon placed on the market from this State.

Gar Pike. *Lepisosteus Osseus* (*Linnaeus*).

This species is also known in North Carolina as long-nosed gar and bill-fish, and is one of the common fish in Albemarle Sound and Neuse River. It has been put on the market to a considerable extent as a food

*North Carolina Geological and Economic Survey, Volume II, page 1, 1907.

fish, and there has been some demand for the skin to be used in covering boxes, sword hilts, etc. As the meat of this fish is well-flavored and wholesome, there is no reason why it should not be used more generally as a food fish.

Sea Cat-Fish. *Galeichthys milberti.*

This cat-fish frequents the beaches, sounds, and bays and is the most abundant of all the salt water cat-fishes, and is put on the market to a limited extent.

Spotted Cat-Fish. *Ictalrus punctatus.*

This cat-fish is reported as abundant in the French Broad River in Madison County, where it is used as a food fish, and is known locally as blue-cat.

White Cat-Fish. *Ameiurus Catus.*

This is one of the best of the cat-fishes, and is marketed to some extent in North Carolina. It is especially abundant in Albemarle Sound and tributaries, and also occurs less abundantly in the Neuse and Yadkin Rivers.

Yellow Cat-Fish. Common Bullhead. *Ameiurus Nebulosus* (*Le-Sueur*).

This cat-fish, which is the common bullhead, occurs abundantly in the western end of Albemarle Sound and in Pasquotank and Roanoke Rivers. While it is marketed to some extent, it is not considered of any large value as a food fish.

Brown Cat-Fish; Mud cat-fish. *Ameiurus Platycephalus.*

This cat-fish is found abundantly in branches of Haw River in Guilford County; in the Little Yadkin River, Rowan County; in Catawba River, McDowell County; St. Johns River, Burke County. Locally it is used largely for food, but very few are put on the market.

Yellow Cat-Fish. *Leptops Olivaris* (*Rafinesque*).

Only in the waters of the French Broad River and its tributary, the Swannanoa River, which are in the Mississippi Basin, has this yellow cat-fish been found. It occurs in these streams in some quantity, and locally is a food fish of some importance.

White Sucker; Sand Sucker; Common Sucker. *Catostomus commersonii.*

This fish is commonly found in the Catawba River in McDowell County, the French Broad and Swannanoa rivers, Buncombe County. It has also been reported from the Yadkin and Neuse rivers. In the French Broad section it is known as sand sucker. In these sections it is considered an important food fish.

Red-Horse; Shiner; White Mullet. *Moxostoma Papillosum.*

This is one of the commonest suckers found in North Carolina, and has been reported from the Dismal Swamp to the Cape Fear River and thence to Georgia. It is common in the Tar River, Edgecombe County, Nuese River, Wake County; Little River, Wayne County; Haw River, Guilford County; Catawba River, Burke County; and Yadkin River, Yadkin and Rowan counties. Locally it is valued highly as a food fish.

White Mullet. *Moxostoma Album (Cope).*

This sucker occurs very abundantly in the Catawba River and is highly valued as an article of food. In size this species is one of the largest, reaching four pounds and over, and is called by the people along the Catawba River, white mullet.

Sucker. *Moxostoma Thalassinum (Cope).*

This species is reported by Cope to have been very abundant in the Yadkin River and used locally for food.

Red-Horse; White Sucker. *Moxostoma Aureolum (LeSueur).*

In North Carolina this sucker only occurs in streams tributary to the Ohio, which are all west of the Blue Ridge. It is found principally in the French Broad River and Spring Creek, one of its tributaries, Madison County. It is used locally as a food fish in that section, where it is known as the white sucker. Fish of this species have been reported to have been caught that weighed twelve pounds.

Red-Horse. *Moxostoma Robustum (Cope).*

This species has only been recorded by Cope, who reported its occurrence in the Yadkin River, and that it was highly valued as a food fish by the people living along the river.

Red-Horse; Golden Mullet; Golden-finned Mullet. *Moxostoma Crassilabre (Cope).*

This species is abundant in the Albemarle region, and the larger fish have considerable market value. At Edenton and Elizabeth City the trade name for this fish is golden mullet and golden-finned mullet. At Plymouth it is on the market as red-horse.

Red-Horse. *Placopharynx Duquesnii (LeSueur).*

This sucker is the common "red-horse" of the rivers in the western part of the State, and is used as a food fish.

Choby; Shiner; Silveryminnow; Smelt. *Hybognathus Nuchalis (Agassiz.)*

This species is found very abundant in Pasquotank and Roanoke rivers and in Albemarle Sound near Edenton. It is caught and utilized to some extent for a food fish.

Horned Dace; Dace; Chub. *Semotilus Atromaculatus (Mitchell).*

This species is found chiefly in brooks and is widely distributed in the State; being known in the French Broad, Catawba, Yadkin, Deep, Neuse, Tar, Cape Fear, and Roanoke rivers and their tributaries. It is a fish of fair size, some weighing as much as four pounds, and although only a fair food fish, it is used to a considerable extent locally.

Roach; Shiner; Shad Roach; Golden Shiner. *Notemigonus Crysoleucas (Mitchell).*

This minnow is very common in all parts of North Carolina east of the mountains, and is found in still and sluggish waters, particularly in the basins of the Catawba, Yadkin, Neuse, Tar, and Cape Fear rivers. It is also very abundant in the Albemarle region, and is caught during the shad season in large numbers in pound nets and seines. It is used for food, but principally for home consumption.

Carp; German Carp; Asiatic Carp. *Cyprinus Carpio (Linnœus).*

The carp was introduced in North Carolina in 1879 and now it is well-known in all parts of the State, but is most plentiful in the warmer and more sluggish lowland waters in the eastern part of the State. While the production of this fish is small, it is one of the commercial fishes, and is put on the market from a dozen or more counties in Eastern North Carolina.

Eel; Common Eel; Fresh Water Eel. *Anguilla Chrispya (Rafinesque).*

This common eel occurs as a migrant in all the streams of North Carolina east of the Blue Ridge, but is only fished for commercially in certain sections in the eastern part of the State, as in the vicinity of Beaufort, Carteret County; New Bern, Craven County; Oriental, Pamlico County.

Conger Eel; Sea Eel; Ocean Eel. *Leptocephalus Conger (Linnaeus).*

This eel occurs somewhat abundantly in the harbor about Beaufort, and in the Newport and North rivers. It has also been found in the salt water sounds. It reaches a very large size, and is an excellent food fish. This fishery is capable of considerable development.

Tarpon; Silver Fish; King Fish. *Tarpon Atlanticus (Cuvier & Valenciennes).*

Each season the tarpon visits the North Carolina coast and enters the sounds as far north as Croatan Sound.

Gizzard Shad; Mud Shad; Nanny Shad. *Dorosoma Cepedianum (LeSueur).*

This species is present in the larger coastal waters of North Carolina throughout the year, and is usually abundant in the sounds and streams

at the time these shad are passing from salt water to fresh water. Although the flesh of this fish is not of specially good quality, there is a market for a certain amount of it, particularly in winter.

Hickory Shad; Hick; Jack; Ship Jack. *Pomolobus Mediocris (Mitchell).*

This species is common in the coast waters and rivers of North Carolina, and in the winter it is caught in large numbers in Pamlico and other salt water sounds. In late winter or early spring it ascends the streams to spawn about the same time that the branch herring are seeking fresh water. Although a much inferior fish to the common shad, it brings a fair price on the market and there is some considerable demand for it.

Branch Herring; Alewife; Branch Alewife; Goggle-eye. *Pomolobus Pseudoharengus (Wilson).*

The alewives are one of the most abundant food fishes inhabiting the rivers of eastern North Carolina, and this State has been the leading alewife State in the country. They occur most abundantly in Albemarle, Croatan, and Pamlico sounds and Neuse River. While many of these fish are put on the market fresh, the principal trade is in the salted fish.

Glut Herring; Herring; School Herring; Blue Back; May Herring. *Pomolobus Aestivalis (Mitchell).*

This herring comes later than the branch herring and usually appears about the middle of the shad season, but spawns a shorter distance from the sea.

Shad; White Shad. *Alosa Sapidissima (Wilson).*

The shad has been the leading commercial fish in North Carolina and extensive fishing is carried on for the shad in the Cape Fear, Neuse, Pamlico, Tar, Roanoke, Chowan, Pasquotank, and Perquimans rivers, and in Albemarle, Croatan, and Pamlico sounds. At one time the shad fishery of North Carolina exceeded that of any other State, but owing, however, to excessive fishing, this fishery has declined to a very marked degree. The industry, however, has begun to feel the effect of the protective legislation that was passed, and it is expected that this fishery will soon be at a highwater mark again.

Hairy-back; Thread Herring. *Opisthonema Oglinum (LeSueur).*

This fish sometimes is found in considerable quantity in Beaufort harbor. It has little or no food value, but has been untilized at some of the fertilizer factories, being taken in hauling for menhaden.

Menhaden; Oldwife; Alewife; Fat Back Shad. *Brevoortia Tyrannus* (*Latrobe*).

This is one of the most valuable of the North Carolina fishes although not used at the present time to any large extent as a food fish. It is caught chiefly for conversion into oil and fertilizer. The principal plants are located in the vicinity of Beaufort, Carteret County; and in the Cape Fear River, Brunswick County.

Smelt; Bait; Anchovy; Striped Anchovy. *Anchovia Brownii* (*Gmelin*).

This fish is very common in the Beaufort Region, Carteret County. While at the present time but little use is made of this fish as a source of food, they do exist in sufficient abundance to support a canning industry. If carefully preserved in oil similar to sardines, this fish ought to meet with a good sale.

Brook Trout; Speckled Trout; Mountain Trout. *Salvelinus Fontinalis* (*Mitchell*).

This trout is more or less abundant in nearly all of the streams of the mountain region of the State which afford excellent fishing. The trout streams represent one of the more valuable resources of the Southern Appalachian Region, and the State realizes the need of keeping the streams well-stocked with trout and protecting them in the interest of the anglers.

Rainbow Trout; California Trout. *Salmo Irideus* (*Gibbons*).

This trout is not native to North Carolina, but was introduced into various streams of the State as early as 1880. While it is not equal to the brook trout as a food or game fish, yet it is better adapted to warmer and more sluggish waters than the brook trout, and to the changed conditions in Western North Carolina, due to cutting of timber, etc.

Pike; Red-finned Pike; Jack; Pickerel. *Esox Americanus* (*Gmelin*).

This pickerel is found in many of the streams, swamps, and lakes of North Carolina. It is caught and used to some extent as a food fish.

Chain Pickerel; Pike; Red-finned Pike; Black Pike; Duck-billed Pike; Jack; Pickerel. *Esox Reticulatus* (*LeSueur*).

This species is common in the lower courses of the eastern rivers of North Carolina. It is found most abundantly about Albemarle Sound, and it is from this section that the greatest quantity of this fish is marketed.

Ohio Muskallunge; Jack. *Esox Ohiensis* (*Kirkland*).

This species was recorded by Dr. Jordan from the French Broad River near Asheville, where is was reported to be one of the food fishes of that section, being known locally as "jack."

Gar-Fish; Bull-fish; Doctor-fish. *Tylosurus Marinus* (*Walbaum*).

This fish is common on the North Carolina coast, and during the spring it enters the sounds seeking fresh water. It is caught to some extent by the fishermen of Albemarle Sound, but is utilized only to a limited extent as a food fish. It is a fish, however, that should be more generally eaten, as its flesh is very palatable.

Flying Fish. *Cypselurus Speculiger* (*Cuvier & Valenciennes*).

This fish inhabits the open seas, and has occasionally been seen at Beaufort. It is a very superior food fish and may become one of the commercial fishes of the State.

Silverside; Sardine; Smelt. *Menidia Menidia* (*Linnaeus*).

This species is common on the North Carolina coast, and has been taken at Beaufort Harbor in midwinter, indicating that it is a permanent resident. It is a palatable fish, and is large enough to warrant its being used as a food fish. At the present time little or no use is made of the fish for this purpose.

Striped Mullet; Mullet; Jumping Mullet. *Mugil Cephalus* (*Linnaeus*).

Of all the salt water fish of North Carolina, this is the most abundant and important, and this State has ranked second in the extent of the mullet fishery. There has been a practice of marketing under-sized mullets and using the smaller ones for fertilizer purposes. This will tend to cut down the supply and may lead to the extermination of this valuable fish. The new Fishery Commission has passed regulations prohibiting this practice.

Mullets are caught in every county bordering on the salt water, but the bulk of the yield comes from Brunswick, New Hanover, Pender, Onslow, Carteret, Pamlico, and Dare counties. The largest recorded North Carolina mullet weighed ten pounds.

White Mullet; Silverside Mullet; Blue-back Mullet; Mullet. *Mugil Curema* (*Cuvier & Valenciennes*).

This mullet is less numerous than the striped mullet, with which it is associated. It is usually not distinguished from the striped mullet by the local fisherman and the two are marketed together.

Little Tunny; Bonito; Bolter. *Gymnosarda Alleterata* (*Rafinesque*).

This species is very irregular in its appearance along the North Carolina coast, but has been caught in the ocean off Nags Head. While at the present time the fish is not regarded with any particular favor as food in North Carolina, yet it is one of the fish that may in time become a commercial food fish of considerable importance.

Tunny; Horse Mackerel; Albacore. *Thunnus Thynnus (Linnaeus).*

This fish, which frequents the North Carolina coast, has not been caught to any large extent, and although a first-class food fish, it is not regarded as such in this country. It is a large fish, and probably could be caught in quantity, if a market could be provided for it, and thus make an important fishery in this country as it does in Southern Europe.

Bonito. *Sarda Sarda (Bloch).*

This fish is caught to a limited extent in the waters of Carteret County, but no particular attempt is made to catch this fish in large quantity, as at the present time it does not rank high as a food fish on our markets. It is, however, an excellent food fish, but unless bled immediately after capture, it is apt to deteriorate. This is probably one of the reasons why the fish has not been more generally considered a good food fish.

Spanish Mackerel. *Scomberomorus Maculatus (Mitchell).*

The Spanish Mackerel is the highest priced fish caught in North Carolina waters and is caught principally by the fisheries of Carteret, Pamlico, Hyde, and Dare counties.

King-Fish; Cero; King Cero; Spotted Cero; Spotted Mackerel. *Scomberomorus Regalis (Bloch).*

This king-fish occurs regularly in summer in Beaufort Harbor, and is caught and used as a food fish. The fishermen do not make any distinction between this and the Spanish mackerel and cero.

Cero; King-fish. *Scomberomorus Cavalla (Cuvier).*

This species has been caught to some extent by the seine fisheries in Carteret County. On account of the fact that it does not have good keeping qualities, it is not regarded as a specially good fish to market fresh, but as a salted fish it is very good.

Amber-Fish; Yellow-tail. *Seriola Lalandi (Cuvier & Valenciennes).*

While but very little attempt is made at the present time to capture this amber-fish, it does occur off the North Carolina coast, and could be found in quantity if properly sought after. Some years ago it was caught off the beaches at Nags Head, Dare County. It has value as a food fish and could probably support a fishery.

Cavally; Olbacore; Albacore; Horse Mackerel. *Caranx Hippos (Linnaeus).*

This species occurs off the North Carolina coast and was formerly caught in considerable quantities at Beaufort, but in recent years it has not been as abundant.

Moon-Fish; Sun-fish; Horse-fish. *Vomer Septipinnis (Mitchell).*

This fish occurs off the outer beach near Beaufort in the fall, and is put on the market to a limited extent.

Gaff-Topsail Pompano. *Trachinotus Glausus (Bloch).*

This pompano has been caught to a limited extent, but does not rank high as a food fish, and but little attention has been paid to it. The principal catch has been at or near Beaufort.

Pompano; Permit. *Trachinotus Goodei (Jordan & Evermann).*

This pompano has been captured to some extent off the shores of Hyde, Carteret, and New Hanover counties; very little use, however, is made of it as a food fish.

Pompano; Sun-fish. *Trachinotus Carolinus (Linnaeus).*

This is one of the best of our salt water food fishes, and has been caught and put on the market from Carteret, Beaufort, and Pamlico counties. This fishery is capable of considerable development.

Blue-Fish; Tailor; Green-fish; Skip-jack; Snapping Mackerel. *Pomatomus Saltatrix (Linnaeus).*

This is one of the more important salt water fishes of the State. The principal fishing for the blue-fish is in Carteret, Dare, Beaufort, Craven, Hyde, New Hanover, Onslow, and Pamlico counties.

Crab-Eater; Cabio; Sargeant-fish. *Rachycentron Canadua (Linnæus).*

This species has been caught to a limited extent off the North Carolina coast from Cape Lookout south, and a market has been found for them in many sections of the State. In some instances this fish has been sold as cero.

Harvest Fish; Star Fish; Star. *Peprilus Alepidotus (Linnaeus).*

In the vicinity of Roanoke Island, in Croatan and Pamlico Sounds, and in Beaufort Harbor, this fish is caught in considerable numbers and is considered an excellent food fish.

Butter-Fish; Butter-perch; Dollar-fish; Harvest-fish. *Poronotus Triacanthus (Peck).*

This fish is caught in considerable quantity in Beaufort Harbor, Pamlico Sound, and at Cape Lookout. It is considered an excellent pan fish, and is marketed in some quantity in this State.

Calico Bass; Strawberry Bass; Crappy; Speckled Perch; White Perch. *Pomoxis Sparoides (Lacepede).*

This fish is common in Albemarle Sound and tributaries, in Tar and Neuse rivers, and other streams of the Coastal Plain Region. It is also

found to some extent in certain of the rivers of the Piedmont Region. This fish ranks high as a game fish, and is also considered a good food fish.

Flyer; Mill-pond Perch; Sun-fish. *Centrarchus Macropterus* (*Lacepede*).

This species, although small in size, is used locally at Plymouth and other places as a food fish and is caught to some considerable extent in the Roanoke, Neuse, and Tar rivers.

Rock Bass; Red-eye. *Ambloplites Rupestris* (*Rafinesque*).

This bass is confined in North Carolina to the French Broad River and its tributaries. As a game fish this ranks high, and it is also a good food fish.

Goggle-Eye; Chub; Mud Chub; Red-eyed Bream; Warmouth; Red-eye. *Chaenobryttus Gulosus* (*Cuvier & Valenciennes*).

This species is reported as common in all the streams east of the Alleghany Mountains, in Albemarle Sound and tributaries, and in the Cape Fear River. It is in the Wilmington markets practically throughout the year, although it is not caught in any great abundance.

Long-Eared Sun-Fish; Red-belly; Robin; Yellow-belly. *Lepomis Auritus* (*Linnaeus*).

This species has been found in some abundance in the Catawba, Yadkin, Neuse, and Cape Fear rivers and Albemarle Sound. It is caught to a limited extent and marketed.

Blue-Joe; Blue Perch; Blue-gill; Blue Sun-fish. *Lepomis Incisor* (*Cuvier & Valenciennes*).

This fish is common in the creeks near Edenton and in Roanoke River at Weldon, and is sold in the local markets. This is the largest and finest of the sun-fishes and stands high as a game and food fish.

Sand Perch; Robin; Robin Perch; Pumpkin-seed. *Lepomis Gibbosus* (*Linnaeus*).

This is one of the commonest fishes and is very abundant in ponds and streams. It is caught in some quantity in Washington, Currituck, Camden, Dare, and other counties in the eastern part of the State, and put regularly on the market.

Small-Mouthed Black Bass. *Micropterus Dolomieu* (*Lacepede*).

This species is known to occur commonly in the Neuse River near Raleigh; Little River at Goldsboro; Swannanoa River near Asheville; and Spring Creek near Hot Springs. It is one of the best game fish and it is also a good food fish.

Large-Mouthed Black Bass; Welshman. *Micropterus Salmoides (Lacepede).*

This bass is found to a limited extent in the mountain region of North Carolina, but it is a fish of the Piedmont Plateau and Coastal Plain regions. It is especially abundant in Currituck Sound and in tributaries of Albemarle Sound. The large-mouthed black bass industry has been larger in North Carolina than in any other State, and Currituck Sound produces about three-fourths of the total yield.

Wall-Eyed Pike; Pike Perch; California Salmon; River Trout. *Stizostedion Vitreum (Mitchell).*

The pike perch fishery has not been developed to any large extent in North Carolina, although its range covers a large part of the State, having been found in the French Broad River and in many rivers of the Coastal Plain Region. This species ranks high as a game fish, and is also considered a splendid food fish. If this fish was cultivated, it could probably be made an important industry in certain parts of the State.

Red-Fin; Yellow Perch; Englishman; Raccoon Perch. *Perca Flavescens (Mitchell).*

The yellow perch occurs rather abundantly in the fresh water streams and sounds and lakes of Eastern North Carolina. It is a good food fish and has been put on the market to some extent. It is also caught in large quantities by anglers. In North Carolina the largest catch comes from Currituck County.

Striped Bass; Rock-fish; Rock. *Roccus Lineatus (Bloch).*

This is one of the largest and best of the fresh water fishes, and is found in many of the fresh water streams of Eastern North Carolina, being especially abundant in the Albemarle Region. This State leads nearly all the others in the quantity of striped bass caught, the most extensive catch coming from Dare County. The other counties marketing large quantities are Currituck, Chowan, Bertie, Martin, Halifax, Washington, Beaufort, and Craven.

Perch; White Perch; Silver Perch. *Morone Americana (Gmelin).*

This fish occurs in the fresh, brackish, and salt waters of Eastern North Carolina, being especially abundant in the Albemarle Sound Region. In Currituck Sound it exists in greater abundance than any other commercial species. It is also found in quantity in New, Neuse, and Cape Fear rivers. Commercially it is more valuable that the yellow perch.

Sea Bass; Black Fish; Bass. *Centropristes Striatus* (*Linnaeus*).

This sea bass, which in North Carolina is called black-fish and bass, occurs in abundance off the coast of North Carolina, and is caught for market in various sections. This fishery should be increased to a considerable extent, and at a good profit. The greater portion of the catch of this fish is from Carteret and New Hanover counties.

Red Snapper. *Lutianus Blackfordi* (*Goode & Bean*).

This important food fish has not been found in any great abundance on the grounds lying off the coast of North Carolina, except in the extreme southeastern portion off Cape Fear, where certain banks are known as "snapper banks."

Pig-Fish; Hog-fish. *Orthopristis Chrysopterus* (*Linnaeus*).

This fish is one of the commonest of the food fishes of the North Carolina coast, occurring as it does in all the sounds and salt water estuaries as well as on the outlying banks. It is one of the leading food fishes of the State, and is caught most extensively in the Beaufort Region, Carteret County, and Pamlico Sound, Hyde County, and on the coast of New Hanover County.

Snapper; Grunt. *Hæmulon Plumieri* (*Lacepede*).

This species undoubtedly occurs regularly on the various banks lying off the North Carolina coast. It is caught in some quantity off the coasts of New Hanover and Brunswick counties, and marketed in Wilmington, where it is known as "snapper." There is a good opportunity of developing this fishery to a much greater extent.

Grunt; Tom-tate; Red-mouthed Grunt. *Bathystoma Rimator* (*Jordan & Swain*).

This red-mouthed grunt, which is abundant at Charleston, South Carolina, should be common along the southern part of the North Carolina coast.

Scup; Pin-fish. *Stenotomus Chrysops* (*Linnaeus*).

This scup has not been caught in very large quantity on the North Carolina coast, and no distinction is made by the fishermen between this fish and the southern scup or porgy (*Stenotomus Aculeatus*).

Southern Scup; Porgy; Long-spined Porgy. *Stenotomus Aculeatus* (*Cuvier & Valenciennes*).

This species should be found at Cape Fear, Beaufort, and other points.

Robin; Sailor's Choice; Pin-fish. *Lagodon Rhomboides* (*Linnaeus*).

This fish is exceedingly abundant at Beaufort, Cape Fear, and elsewhere on the North Carolina coast, where it is known as pin-fish, and

robin. It was formerly thrown away, but is now becoming a commercial fish, and is marketed in some quantity in this State, principally at Wilmington.

Sheepshead. *Archosargus Probatocephalus* (*Walbaum*).

This species occurs in all the bays and estuaries of the North Carolina coast, although nowhere is it found in very great abundance. Carteret, Dare, Beaufort, and Pamlico counties produce the greatest yield.

Squeteague; Trout; Weak-fish; Sea Trout; Gray Trout; Summer Trout. *Cynoscion Regalis* (*Bloch & Schneider*).

This species is abundant along the North Carolina coast, but not in as large numbers as the spotted trout; and like it, is present almost throughout the year.

Spotted Squeteague; Speckled Trout; Sea Trout; Trout; Spotted Weak-fish; Southern Squeteague; Black Trout; Salmon Trout. *Cynoscion Nebulosus* (*Cuvier & Valenciennes*).

This fish is very abundant in North Carolina, and from an economic standpoint is the principal member of the drum family.

Yellow-Tail; Perch; Silver Perch; White Perch; Yellow-finned Perch; Sand Perch. *Bairdiella Chrysura* (*Lacepede*).

The yellow-tail abounds in North Carolina sounds, estuaries, and salt waters generally from early spring to late fall. Although a small fish, it makes an excellent pan fish, comparable with the spot, and could be made of some considerable economic value.

Spot. *Leiostomus Xanthurus* (*Lacepede*).

The spot is very abundant in the sounds and other coastal waters of North Carolina, and in certain seasons enters perfectly fresh waters. North Carolina spots find a ready market in Baltimore, Washington, and other cities.

Croaker; Crocus; Hard-head. *Micropogon Undulatus* (*Linnaeus*).

This is another one of the common food fishes of the North Carolina coast, being found in nearly all the sounds, estuaries, and inlets and on the outer shores. The croaker is caught along the entire coast and has become one of the very salable species.

Drum; Red Drum; Red-fish; Spotted Bass; Channel Bass. *Solaenops Ocellatus* (*Linnaeus*).

The Red Drum is one of the larger and more valuable of the food fishes, but as a fishery it has not been developed to as great an extent

as it should be. This fishery is most extensive in Carteret County, but the fish are also caught in the Cape Fear Region and about Roanoke Island.

Sea Mullet; King-fish; Carolina Whiting; Round-head; Whiting; Sea-Mink. *Menticirrhus Americanus* (*Linnaeus*).

This fish is abundant about Roanoke Island, Pamlico Sound, around Cape Lookout, Beaufort Harbor, and Cape Fear. This fish is of exceptionally good quality, and at times commands a fancy price.

King-Fish; Sea Mullet; Sea-Mink; Whiting. *Menticirrhus Saxatilis* (*Bloch & Schneider*).

This species is usually not distinguished by the North Carolina fishermen from the preceding species, *Menticirrhus Americanus*. This fish is especially esteemed in New York and New Jersey markets. It is probable that if the king-fish were separated from the sea mullet or Carolina whiting, that it would bring a better and more constant price.

Surf Whiting; Sea Mullet; Whiting; Silver Whiting. *Menticirrhus Littoralis* (*Holbrook*).

This whiting is rather common at Beaufort during the summer, and is marketed with the two preceding species.

Black Drum; Sea Drum. *Pogonias Cromis* (*Linnaeus*).

The black drum is less abundant than the red drum in North Carolina, and nowhere near as valuable a food fish. It is very seldom shipped, and the principal use of it as a food fish is made locally by some of the fishermen.

Tautog; Oyster-fish. *Tautoga Onitis* (*Linnaeus*).

This fish is not very abundant in North Carolina, and while it does not support a special fishery, it is some years caught in considerable numbers, especially in the waters of Beaufort Harbor.

Porgee; Spade-fish; Moon-fish. *Chætodipterus Faber* (*Broussonet*).

This species is found on the North Carolina coast only in summer. Its flesh is of excellent quality, and there is considerable demand for it in the New York and Washington markets. The bulk of the catch has come from Craven, Dare, and Pamlico counties.

Sun-Fish; Head-fish; Moon-fish; Mola. *Mola Mola* (*Linnaeus*).

This sun-fish, which attains a weight of fifteen hundred pounds, may become of economic value if it is determined that glue may be made from the abundant subdermal elastic tissue.

Cod. *Gadus Callarias* (*Linnaeus*).

At the present time cod fishing is of little or no importance in this State, but this species is known to occur regularly on the North Carolina coast north of Cape Hatteras, and it is possible that a winter cod-fishery of some importance might be established on the northern part of the coast. According to Dr. Smith, the fish will be found in greatest abundance on the off shore shoals, and could be caught easily with lines or gill nets.

The Flounders. Family *Pleuronectidæ*.

There are seven flounders that are known to occur in the North Carolina waters, or on the adjacent ocean bottom, and this fishery has become of considerable increasing economic importance in the State. The bulk of the production comes from Beaufort, Carteret, Dare, Hyde, and Pamlico counties.

Flounder; Summer Flounder; Mud Flounder; Sand Flounder; Plaice. *Paralichthys Dentatus* (*Linnaeus*).

The summer flounder is one of the most valuable of the flat fishes. Although a salt water fish, it is often caught in fresh water streams far from salt water.

Southern Flounder; Flounder. *Paralichthys Lethostigmus* (*Jordan & Gilbert*).

This flat fish is similar in size and habits to the summer flounder, and is more common in the coast and salt waters of North Carolina. It regularly resorts to fresh waters, and, according to Dr. Smith, is the only local flounder with that habit. It is common in the western end of Albemarle Sound.

Flounder. *Paralichthys Albiguttus* (*Jordan & Gilbert*).

This flounder is common around Beaufort and Cape Lookout and usually is not distinguished by the fishermen or merchantmen from the other flounders.

While some of the fishes enumerated above are only produced to a limited extent in this State, yet all of them do represent a portion of the natural food supply of the State, and many of them offer opportunities for much larger developed fisheries. Owing to the scarcity of certain of the more desirable fish, some of those which formerly had been considered of little or no value as a food fish have been found to be very palatable, stand transportation well, and when put on the market find a comparatively ready sale, although sometimes at rather low prices.

If North Carolina will cater to the trade, and take particular care in the packing of the fish for transportation, in refraining from trying to put undersized fish on the market, and keeping the fish in their own class, so that a certain trade name will always mean a certain fish, there is no reason why the fin fisheries of the State should not be greatly increased both in production and value. One phase of the work of the Fisheries Commission is along this line, and they are trying to have all the fish product from this State go out as North Carolina fish. With the increased railroad facilities in Eastern North Carolina, it is now possible for the fisheries to ship their products into all parts of the country in competition with any of the other Atlantic States.

More attention is being given to the development of new fishing grounds, particularly to those off shore on the submerged banks, and in the surface waters; also to a more thorough exploitation of the old fishing grounds. Another means of increasing the industry which the State through its Commission has recognized and is trying to carry out, is to increase the abundance of fish through cultivation. Still another means of increasing the industry and which to the author is one of the more important ones, is the utilization of certain fishes which are now considered of little or no value. The United States Bureau of Fisheries has demonstrated conclusively that by a systematic advertisement, fish which are known to be palatable and are a good source of food, can be made to become a very marketable fish. This is well illustrated in the tile-fish, which through the efforts of the Federal Government has become a commercial fish of considerable importance. This Bureau has also been successful in bringing the sea-mussel on the market as an article of food. Now they are considering a well-known member of the shark family as a food fish, and, personally, I can see no reason why this particular member of the shark family, which unfortunately is known as dog-fish, should not become a staple article of food marketed in steaks similar to the sword-fish. The suggested commercial name is grayfish.

In speaking of the future of the fin fish industry in North Carolina, Dr. Hugh M. Smith stated:*

The fisheries may be expected to deteriorate—

(*a*) Through failure of the State to provide prompt and adequate protection to those fishes which begin to show a decrease in abundance. The history of the sturgeon is an unmistakable indication of what will eventually happen to the shad, alewives, striped bass, and other species unless ample provision is made for the survival of a sufficient percentage of the annual run until spawning has ensued.

*North Carolina Geological and Economic Survey, Volume II, page 412, 1907.

(*b*) Because of unnecessarily wasteful methods, such as the capture of larger quantities of food fishes than can be utilized or disposed of to advantage and the useless destruction of large numbers of fishes of no present market value but of prospective importance.

(*c*) Owing to careless methods of packing and preserving the catch, and the failure to keep abreast of the progress of the times in matters affecting the shipment and sale of fish.

The State is already taking cognizance of Dr. Smith's warnings (a) and (b), by the passage of the Fisheries Commission bill, which provides legislation for the protection of the fishes of the State and machinery for enforcing the laws. Also the Commission has the authority to regulate methods of catching and disposal of fish, which will prevent the waste in warning (b). The question of methods of packing and preserving the catch is receiving serious consideration and improvement is being made along this line.

Thus there is every reason to believe that the fisheries of North Carolina will not only be maintained for an indefinite period, but will show marked growth in production and value.

Oyster Industry

North Carolina at the present time not only does not hold first place in the country in the oyster industry, but as has been stated by the Oyster Commissioner of Virginia,* "Maryland is far behind Virginia in the laws and methods of administration of its oyster industry, while North Carolina is hardly in the running." Since that time conditions have changed, and North Carolina now leads in laws and methods of administration, although not yet in production. If the present law can remain in force, it will not be many years before the oyster industry of North Carolina will be equal to that of any South Atlantic State.

In the case of the oyster, as with certain of the fin-fish, it will be necessary for the Fisheries Commission to insist that the oysters caught and marketed in this State shall be put on the market as North Carolina products. The Pamlico and New River oysters are equal to those caught in any other State in this country, and if the beds producing these oysters are cultivated and protected and the oysters vigorously advertised, it will not be long before the Pamlico oyster and the New River oyster will be as widely known as the Lynnhaven and the Blue Point.

The oyster canning industry is also capable of very large development in this State, and the Fisheries Commission are already taking steps to obtain legislation which will prevent the North Carolina canned oyster from being shipped as Virginia stock.

*"Virginia Fishing Industry," Oystermen and Fishermen, April, 1911, page 9.

A very satisfactory law regarding the cultivation of the oyster was passed by the General Assembly of North Carolina,* but very little was accomplished under this law until the passage of the Fisheries Commission bill in 1915. Now the cultivation of the oyster is beginning to receive more serious consideration.

When we stop to consider that Pamlico Sound is as large as Long Island Sound, where something over 80,000 acres are under cultivation; and something like half as large as Chesapeake Bay, where approximately 20,000 or more acres are held for cultivation, it will be realized that the possibilities for oyster culture in this State are very large. The State has already proved through experimental work that the cultivation of the oyster can be carried on profitably in this State.†

Oystering is carried on in ten counties, Dare, Hyde, Beaufort, Pamlico, Craven, Carteret, Onslow, Pender, New Hanover, Brunswick. The greatest number of oysters, however, are taken from Hyde, Beaufort, Dare, Carteret, and Onslow counties.

Round Clams (Quahogs). The clam industry has never become of great importance in this State, although there are certain sections where it is capable of being developed to a considerable extent. A few experiments have been made regarding the cultivation of the clam which were rather successful. At the present time what clams are produced come principally from Brunswick and Carteret counties. This industry is capable of very large development in this State.

Scallops. Only very small quantities of scallops have been gathered and marketed in this State and these were obtained in Carteret County. No particular investigation has been made in regard to this phase of the fishing industry of the State, but it is believed that it can be developed to a very much greater extent than it is at the present time.

Crabs. The principal crab that is caught in North Carolina is the common blue crab, and nearly the entire catch is sold in the softshell stage. Very few people realize that there is any crab industry in this State, for the reason that at present practically all of the crabs are shipped by Chrisfield, Maryland, packers, and usually go on the market as Maryland crabs. This industry is small, but is capable of very large development and if the plans of the Fisheries Commission can be carried out it will be developed as a North Carolina crab industry. The crabs that are marketed are taken generally in Carteret County, although a good many are caught in Dare County around Roanoke Island. Although crabs are caught for local use in nearly all of the salt water counties, very few are put on the general market except from Carteret.

*Public Laws of North Carolina, Chapter 871, Section 1909.

†See Bulletin 15, North Carolina Geological and Economic Survey, 1907, on Experiments in Oyster Culture in Pamlico Sound.

Shrimp. The shrimp industry is confined to Brunswick, New Hanover, and Pender counties, the two former having the larger production. Little thus far has been done to develop this industry, but measures have been taken by the Commission to protect it and prevent its wasteful destruction.

Reptilian Water Resources. Of the reptilians there occur in North Carolina alligators, green and other sea-turtles, diamond back and other terrapins, and frogs. Of these the terrapin and frog are to be considered of commercial importance. A series of experiments were conducted in regard to the cultivation of the diamond back terrapin, which proved successful,* and already one company has been organized and is carrying on the cultivation of the terrapin at Beaufort, North Carolina. The diamond back terrapin is taken in small numbers about Roanoke Island and on the marshes of Beaufort Harbor.

Frogs are hunted and marketed to a limited extent in Pasquotank and Camden counties.

The above will give some idea of the fishing resources of the State, which it is believed will in the near future be worth, instead of a few million, seven or eight million dollars per year to the State.

In closing I wish to say a word in regard to the cultivation of fishes in North Carolina, inasmuch as this State was one of the first to take up artificial propagation of fishes. I believe that the State can make no better expenditure of funds in connection with the fishing industry than in systematic fish culture, and I believe further that it is the duty of the State to establish and maintain several small hatcheries to assist in the replenishment of certain desirable fishes in our upland as well as lowland streams. This State has had the hearty coöperation of the Federal Government in the development of its fisheries, and the United States Bureau of Fisheries has maintained a shad hatchery at Edenton for a great many years.

With the passage of the Fisheries Commission Act, which should insure the enforcement of laws and the protection of the fish, there is still more reason for an increased number of hatcheries in this State, and greater coöperation of the State Commission with the United States Bureau of Fisheries. It is to be hoped that the two Commissions will take up the artificial propagation of the sea-mullet, spotted squeteague, and other valuable salt water species, in addition to the cultivation of the brook trout, rainbow trout, small-mouthed black bass, and spotted cat-fish for the mountainous regions; and the large-mouthed black bass, strawberry bass, and various sun-fishes for the lowland waters.

*Cultivation of the Diamond Back Terrapin, Bulletin 14, North Carolina Geological and Economic Survey, 1906.

FISH HATCHERIES IN NORTH CAROLINA*

1915

Edenton Hatchery

On Albemarle Sound the climatic and other physical conditions during the spring of 1915 were identical to those of last season, which proved unfavorable to the shad operations at the Edenton, N. C., station. Although every field where there was a possibility of securing spawn was covered by experienced spawn takers, and the scope of the work was extended to fields in the lower end of the sound heretofore unoccupied, the result of the season's work shows a decrease of 6,333,000 in the output of shad fry as compared with the previous year. The 39,040,000 eggs received at the hatchery from all sources yielded 22,990,000 fry, most of which were distributed in North Carolina, although liberal plants were made in suitable waters in adjacent Southern States.

Roanoke River Hatchery

The usual preparations for propagating striped bass on the Roanoke River at Weldon, N. C., were completed early in April. Suitable traps in which to capture the brood fish and pens for holding them were located at advantageous places in the river, seven collecting points being established adjacent to grounds operated by the commercial fishermen. The prospects in April for a large run of fish were very encouraging, but early in May the river fell to a very low stage, and clear water prevailed throughout the spawning season. Abnormally high temperatures hastened the spawning of the fish, and many of them deposited their eggs in the river. Owing to excessively low water and the faulty construction of the retaining boxes, the penning operations were a failure, as many of the fish held injured themselves so badly that they died before their eggs ripened.

The first eggs were secured April 25, and from that time on collections in limited numbers were made until the end of the spawning season, on May 17, 2,500,000 constituting the largest take of a single day. The difficulty experienced last year in obtaining ripe male fish at the time eggs were available was again encountered, and large losses of eggs occurred through lack of a fertilizing medium. In one instance two females weighing 40 and 35 pounds, respectively, and carrying approximately 5,000,000 eggs, were taken in traps, but as no males were at hand, all of the eggs were lost.

*These are operated by the United States Bureau of Fisheries, and the information given is from the reports of the Commissioner of the Bureau of Fisheries for the years 1915 and 1916.

The total egg collections amounted to 11,295,000, from which 6,640,000 were hatched. The discrepancy between the collections and the output was due to abnormally high temperatures, which caused a heavy loss of eggs in the hatchery.

1916

Edenton Hatchery

In Albemarle Sound slightly over 16,000,000 shad eggs constituted the season's collections, making it one of the poorest experienced since the establishment of the Bureau's station in that region. While the unfavorable showing was due in some measure to the cold northerly winds which prevailed throughout the spawning period, it is yearly becoming more evident that the Bureau's efforts to maintain the shad fisheries of Albemarle Sound are not appreciated by all those who are deriving most of the benefit therefrom. The gill-net fishermen, to whose coöperation the Bureau is indebted for the successful shad work in recent years, are gradually being driven off the spawning grounds by the encroachments of the pound-net fishermen, who apparently take no interest in the work of artificial shad propagation. The records of the Edenton station show that the number of fishermen—principally gillers—furnishing eggs to the hatchery increased from 31 in 1910 to 67 in 1913, in which year the largest egg collections in the station's history were made. Since that time the operations of the gillers have rapidly declined, and only 17 were left to furnish eggs for the Bureau's work in 1916. The output of fry from the eggs obtained numbered 9,765,000.

Plans were made early in the spring at the Edenton station to undertake the hatching of the white perch, but the efforts to obtain eggs resulted in practical failure, only 1,200,000 being secured. The reason advanced for this poor outcome is the irregularity and uncertainty of the ripening of the fish, a feature which, from all accounts, has always existed in the Albemarle Sound region. The collection of these eggs began in March and extended well into April, and the output of fry was 850,000.

Roanoke River Hatchery

With the view of prosecuting striped-bass work on a more efficient and extensive basis than heretofore, a time lease was secured on a building on the west bank of the Roanoke River, which was fitted up in advance of the spawning season. The opening of the spawning season was delayed by heavy rains in April, but, aside from the shortening of the season by its late beginning, natural conditions were quite favorable and the season proved to be very successful, 13,325,000 eggs being taken and 10,071,000 fry hatched therefrom.

OUTPUT OF EDENTON, N. C., STATION FOR FISCAL YEARS 1915 AND 1916

1915

Species	Fry	Fingerlings	Total
Black bass	21,000	95,950	116,950
Shad	22,990,000		22,990,000
Sunfish		23,750	23,750
White perch	4,500,000		4,500,000
Totals	27,511,000	119,700	27,930,700

1916

Black bass	18,300	15,975	34,275
Rock bass		2,800	2,800
Shad	9,765,000		9,765,000
Sunfish		11,750	11,750
White perch	850,000		850,000
Totals	10,633,300	30,525	10,663,825

OUTPUT OF WELDON, N. C., STATION FOR FISCAL YEARS 1915 AND 1916.

1915

Striped bass	8,594,500		8,594,500

1916

Striped bass	10,071,000		10,071,000

SHAD WORK ON CAPE FEAR, 1916

The shad work was extended during the year by the establishment and operation of an experimental field station on the Cape Fear River in North Carolina.

The shad work on the Cape Fear River was undertaken largely at the request of the State authorities and members of Congress, in order that the fishermen of that section of the State might receive some recognition for having been brought—very tardily, it must be said—under the provisions of the protective fishery laws that for years had applied to other parts of the State. The steamer *Fish Hawk,* equipped as a floating hatchery, was sent to the river, and a temporary hatching plant was set up at a convenient point on the river bank above Wilmington.

The run of shad on the Cape Fear proved to be small, and of the shad taken at the various fisheries only one individual with ripe eggs was found by the spawn takers detailed for the work. The material results of this experiment were, therefore, wholly negative, but the experience gained will doubtless be helpful in connection with any future operations which may be considered for that field.

INVESTIGATIONS AT THE BIOLOGICAL LABORATORY, BEAUFORT, N. C.

The Beaufort, N. C., laboratory is a center for investigations that look to the better development of the fisheries of the South Atlantic coast. Allusion has been made to the study of the mullet and to the survey of fishing grounds which has revealed opportunities for offshore winter operation and contributed to the development of a fishery that is as yet unduly limited. The successful experiments in terrapin culture are also more fully described elsewhere. Special attention is being devoted to the breeding habits of fishes, the larval development of fishes, and, as opportunity offers, to the possibilities of propagation of certain sea fishes which support important fisheries in the South Atlantic States. Interesting observations were made and a report was prepared dealing with the habits of certain species of small fish that are denizens of brackish and fresh waters, and that are serviceable in the extermination of mosquito larvæ and hence in the maintenance of public health.

Efficient study of the food of fishes and of the movements of fishes, as directed by the search for food, or the avoidance of enemies, demands an exact knowledge of the forms of animal and plant life which may be encountered in the local waters or which may be found in the stomachs of the fishes. Careful systematic studies of certain groups of animal and plant life have therefore been in progress for some time. During the past fiscal year there was completed for publication a valuable report on the sharks and rays of the Beaufort region; and another comprehensive report dealing with the decapod crustacea, a group that includes the crabs and other forms of most direct economic usefulness, has also been completed and submitted for publication. Systematic studies of certain groups of fish parasites have been completed. A report of the algæ of the region is nearing completion, while the diatoms and protozoa, among the lowest forms of minute plant and animal life, as well as the higher fishes, are now subjects of investigation.

In the assurance that the development of commercial fisheries will soon demand more strongly the conservation of important shellfish, serious attention is being given to the life history of the quahaug or hard clam and the principal crustacean forms.

The Beaufort laboratory has also been found a favorable place for the prosecution of certain special problems that have not a particular regional significance. At this place there are pursued investigations of the toxicity of certain chemicals to marine borers and of the protection of wood against these disastrous pests, in which studies the Bureau has enjoyed the coöperation of the forest products laboratory of the Forest Service and the sympathetic interest of railway companies and other commercial bodies.

The enlargement of the island upon which the laboratory is located, in consequence of the deposition of material dredged by the War Department from nearby channels; the recent additions to the building authorized by Congress; and the grading and sodding of large portions of the island have added greatly to the appearance and to the stability of the property. The station would be of much greater practical service to the fishing industries of the coast were it enabled, through the provision of an adequate permanent staff, to carry on more extensive permanent experimental work. Investigations temporarily pursued serve a useful purpose in laying the basis for practical work, but it is usually only through continuous experimentation that the inevitable difficulties of new practical work are discovered and successfully overcome, as must finally be done to pave the way to substantial benefits. The terrapin experiments offer a concrete example of a businesslike mode of procedure in fishery experiment work, while other opportunities are awaiting with perhaps greater possibilities.

The North Carolina Fisheries Commission has a wonderful opportunity for carrying on investigations relating to the fisheries problems by reason of the existence of the Beaufort Laboratory and its splendid equipment, which can be used by the State Commission. Then again, the United States Bureau of Fisheries is ready and willing to coöperate in every way possibly with the State Commission in carrying on these investigations.

PROGRESS OF DIAMOND-BACK TERRAPIN CULTURE

The success which has previously been attained in the experiments in terrapin culture has been continued in the past year in even more marked degree. It is timely to summarize some of the more important results at the Beaufort Laboratory.

(1) Perhaps the most interesting development of the year is the fact that the three oldest broods of terrapin that were hatched in the experimental pounds and grown in captivity have produced eggs. The two oldest broods, one of which had been winter-fed during the first season while the other had been permitted to hibernate, began laying in 1915 and the eggs hatched successfully. The terrapin of the hatch of 1911 laid eggs in 1916, before the close of the fiscal year. These significant inferences may be made: (*a*) That terrapin born and reared in confinement develop in a normal way and will reproduce their kind; (*b*) That the reproductive cycle may be completed in six years, even though the terrapin hibernate as in nature; (*c*) That by preventing hibernation

and forcing growth through the first winter by feeding in a heated house the maturity as well as the growth of the terrapin may be advanced by one year, so that a new generation is started in five years rather than in six.

(2) The adult breeding stock of terrapin has from year to year steadily increased in productivity, and there is ground for belief that the adult breeders have not yet reached the maximum capacity for reproduction. The following figures show the number of young produced by adult breeders during each of the past four years and also the average number per female yielded by the original stock of breeders:

Year	Number of Young from All Adult Breeders	Average Number per Female of Original Breeding Stock
1912	1,326	12.81
1913	1,506	14.52
1914	1,690	15.23
1915	2,128	21.43

Those terrapin which have been longest in captivity produced in 1915 an average of 21.43 young for each female.

(3) The value of winter feeding during the first season is well established by the increased rate of growth, the shortening of the time required to attain reproductive maturity, and the very low rate of mortality. The death rate has never been so low as during the winter of 1915-16. Among 700 terrapin fed on fresh food the loss was about 6½ per cent, while among those fed on salted food the loss was about 8⅓ per cent. The death rate in hibernating stock was 13 per cent. The cost of food for winter feeding at Beaufort varies from 3 to 15 cents per 1,000 young terrapin per day, according as salt fish, fresh fish, or oysters are used. Assuming 10 cents as an average daily expenditure per 1,000 terrapin, the cost of food for 1 terrapin for a period of 5 months in the first winter would be 1½ cents.

(4) The death rate among terrapin after the first season is so small as to be nearly negligible. It is found to be about 1 per cent in the second year, diminishing with age to one-half per cent and less. The principal mortality occurs in the first season, and is then found to be chiefly among the "runts," which should probably be culled out in ordinary practice. While the death rate has been as high as 20 to 25 per cent during the first season, it has now been reduced, partly through improved methods of sanitation, to less than 10 per cent. The losses are remarkably low when it is considered that deaths occur principally when terrapin are very young and before they have become a source of

expense, and that the productivity of the terrapin is such that even a loss of 30 per cent at this stage could readily be compensated for by increasing the numbers hatched and saved for rearing. So far as regards disease and death rate the rearing of terrapin is a matter of much less difficulty than the raising of poultry.

(5) The history of our experiments during many years gives strong grounds for belief that domestication of terrapin is accompanied by increasing productivity and diminishing disease and mortality. Our experience indicates the advisability of retaining a select brood stock for a rather indefinite period, instead of adopting new breeders from year to year, as might be done in stock raising. Some of the breeders have been in captivity for about fourteen years.

It may be noted that the experiments in terrapin culture have not the nature of small laboratory tests but are carried out upon such a scale as to be comparable to commercial operations. It is possible also to check our results against those obtainable in a large local commercial venture which has adopted methods based upon those followed in the Bureau's work. From this it appears that the various results gained in the Bureau's experimental work are not to be taken as exceptional, but that they are, in a general way, typical of what may be expected in cultural operations conducted according to sound principles and with the exercise of proper care.

There are now about 3,000 terrapins under observation and classified in more than twenty-five experiments which are being directed to obtain definite answers to practical questions that yet demand attention and justify the continuance of the investigations. Among these are: What is the proper proportion to maintain between males and females, and what are the best conditions for prolificness in eggs and for successful hatching? What are the possibilities of improving rate of growth by selection, and what are the opportunities for promoting economy through proper culling or other methods? These are only some of the practical questions which warrant further investigations.

SURVEYS OF FISHING GROUNDS

Some further work has been done in extending the known limits of the blackfish grounds off the coast of North Carolina. The Bureau maintains a buoy on the principal grounds, which is of service to fishermen both in locating this particular ground and as a bearing from which to find other grounds. The fishery is not developed in proportion to the evident possibilities, owing partly to the lack of suitable boats and partly to the unwillingness of local fishermen to engage in operations at any distance from the shore. One or two crews have, however,

taken advantage of the opportunities and the fishery was regularly followed through the winter and spring of 1915-16, with results that were very satisfactory to the fishermen and the vessel owners.

MAGNETIC SURVEY

Meridian monuments for determining the variations of the magnetic needle of the compass from the true North and a standard length for measuring surveyors' chains have been established at the county seats of the several counties of the State. This work was originally done by the United States Coast and Geodetic Survey in coöperation with the North Carolina Geological and Economic Survey, and since their establishment the State Geologist has had the hearty coöperation of the Federal Bureau in having magnetic observations made at old stations and new stations established.

MAGNETIC OBSERVATIONS MADE DURING 1915 AND 1916

During 1915 and 1916 the following magnetic observations were made by the United States Coast and Geodetic Survey in North Carolina:

Concord, Cabarrus County.—The station of 1899 was unsuitable for further magnetic observations. The new station is about two-thirds mile northwest of the old one and is located in the southwest central portion of school ground No. 2. It is at the north end of a tennis court and about midway between a lone oak and the shrub fence on the west, being 24.8 feet from the fence and 23.9 feet from the tree. The station is marked by a granite post 8 by 6 by 30 inches, with a bronze disk in the top which projects about 3 inches above ground. The following true bearings were determined:

	°	′	
East side of telegraph pole north of station (mark)	6	40.7	west of north
West gable of residence 500 feet distant	58	52.9	east of north
North corner of main school building	78	40.4	east of south
Extreme west corner of school building	38	11.0	east of south
East gable of dwelling 300 feet distant	26	31.4	west of south

The north end of a meridian line about 285 feet long is marked by a granite post 8 by 38 inches, with a marker and projects about 6 inches above ground.

There are four auxiliary stations established in the vicinity of Concord.

No. 1 is about four miles from the primary station, on the North Charlotte road running in a southwesterly direction from town. Observations were made about 50 feet back from the main road on the farm road leading to the barn on Morris's farm.

No 2 is about four miles from the primary station, at Cook's Crossing, nearly due north of town. Observations were made about 150 yards west of the crossing on the north side of the road running due west from the crossing.

No. 3 is about four miles from the main station, on the Mount Pleasant Road. It is at the summit of a hill which may be distinguished by the grade of the road running over it, which is a steady grade of about 3 per cent, beginning a mile or more on the west. Observations were made about 100 feet south of this road near the highest point.

No. 4 is about four miles from the main station, on the Bost Mill Road running a little southeast of the town. Observations were made on the grounds of an old church having a cemetery on the northwest side of it.

Salisbury, Rowan County.—The station of 1905 was re-occupied. It is in Chestnut Hill cemetery, 17.7 feet due south of the south meridian stone. As this locality was not well suited for a magnetic station, a new station was established at the County Fair Grounds, about 1½ miles northwest of the town's center. It is in the southern part of the infield within the race track; 131 feet north from the fence surrounding the infield; and 309 feet southeast from the nearest point of the judge's stand. It is marked by a marble post 6 by 4 by 26 inches, with a bronze disk set in the top, projecting 2 inches above the ground. The following true bearings were determined:

	° ′	
Top of First Baptist Church steeple (mark)	36 49.0	east of south
Top of belfry of public school	18 00.1	east of south
Top of the east cupola on a church tower	7 39.2	east of south
Upper southeast corner of tower of the new school for girls	28 59.7	east of north
Top of south cupola of the main exhibition building	14 15.2	west of north

Morganton, Burke County.—The station of 1906 was re-occupied, but owing to the proximity of the county jail, a new station was established about one mile to the southwest. It is in the southeastern part of the grounds of the North Carolina School for the Deaf, north of the Superintendent's house, and about one mile southwest from the town's center. It is 214.4 feet northwest from the northeast corner of the front piazza of the Superintendent's house, and 226.8 feet northeast from the northwest corner of the piazza. It is marked by a cement monument 12 by 12 by 30 inches long, projecting 6 inches above the ground, with a bronze disk set in the rounded top. The following true bearings were determined:

	°	′	
Top of water tank at State Asylum for the Insane (mark)	79	13.0	east of south
Top of second cupola east of water tank at Insane Asylum	80	11.8	east of south
Top of fourth cupola east of water tank	81	01.1	east of south
Central west gable of Goodwin Hall	68	00.2	east of north
Top of M. E. South Church steeple	1	24.0	west of north
Tip of cupola over office of school	85	22.4	west of south

An iron rod was set 600 feet distant to mark the north end of a meridian line.

Chapel Hill, Orange County.—The station of 1906 was re-occupied, but owing to the proximity of a brick building which was re-enforced with steel beams, a new station was established in the northeastern part of the grounds of the University of North Carolina, about one-quarter mile east from the town's center. It is 206 feet from the south meridian stone established in 1898, in line with that stone and the southeast corner of the geological building; 242.5 feet northeast from the southeast corner of Davie Hall; and 160.7 feet from the stone boundary wall to the east. It is marked by two pint glass bottles, one above the other, buried two inches under the ground. The following true bearings were determined:

	°	′	
South meridian stone (in line with southeast corner of geological building) (mark)	59	27.3	west of south
Lower northeast corner of Davie Hall	53	07.7	west of south
Northeast corner of Caldwell Hall	12	17.9	west of south
Southwest corner of chemistry building	78	19.7	west of south

Graham, Alamance County.—The old station was located so near to an electric car line and other disturbances that observations were impracticable, therefore a new station was located about one-half mile due east of the old one. It is in the extreme eastern central part of the town cemetery, which is marked by a thick woods. It is at the east end of the main road leading into the cemetery, 350 feet almost exactly due east from a small rest pavilion and pump in the center of this road, and 27 feet northwest of a large and prominent tree at the end of the road. The exact spot is marked by a bronze disk in the top of a cement post 8 by 8 by 30 inches, projecting two inches above the ground. The following true bearings were determined:

	°	′	
West gable of residence one-fourth mile distant	8	22.1	west of north
South edge of building 300 yards distant	16	44.9	east of north
Apex of monument marked "Holt"	88	04.8	west of south
Apex of pavilion roof	89	57.7	west of south
Christian Church spire	48	13.9	west of north

Halifax, Halifax County.—Observations were made over the south stone of the meridian line established in 1899, but owing to the presence of iron in the vicinity a new station was established in the southeastern part of the lot known as the grounds of the old Jones house. It is about one-half mile southwest from the town's center, 176 feet a little north of west from the west track of the Atlantic Coast Line Railroad; 37.3 feet from the boundary line to the south; and 76 feet northwest from the center of the trunk of a large white oak tree at the south end of the grove. It is marked by a slab of marble 1 by 8 by 15 inches, which rests on a marble base, and projects about one inch above the ground. A cross in the top indicates the exact spot. The following true bearings were determined:

West gable of a sheet iron storehouse on east side of railroad track south of depot (mark) ..... 21 35.8 east of north
Upper southwest corner of R. E. Daniels' house, under eaves ..... 77 52.6 east of north
Top of semaphore pole on east side of railroad track.. 4 50.5 west of south
Top of the warning sign-post at the railroad crossing.. 58 07.8 east of north

RESULTS OF MAGNETIC OBSERVATIONS MADE IN NORTH CAROLINA BY THE UNITED STATES COAST AND GEODETIC SURVEY BETWEEN DECEMBER 1, 1914, AND NOVEMBER 30, 1916.

Station	County	Latitude	Longitude	Date	Declination	Dip	Horizontal Intensity	Observer
					West			
Concord	Cabarrus	° ′	° ′		° ′	° ′	γ	
Auxiliary 4		35 21	80 34	May 17, 1915	3 38	67 23	21892	F. Neumann.
Auxiliary 1		35 22	80 38	May 17, 1915	0 52	66 55	22453	F. Neumann.
Auxiliary 3		35 24	80 31	May 17, 1915	2 13	67 14	22058	F. Neumann.
New		35 24	80 36	May 15, 1915	3 30	68 02	21399	F. Neumann.
Auxiliary 2		35 28	80 35	May 21, 1915	2 15	67 44	21239	F. Neumann.
Salisbury	Rowan							
Old		35 40	80 30	April 30, 1916	0 57	67 54	21485	W. M. Hill.
Auxiliary		35 40	80 30	May 1, 1916	1 00			W. M. Hill.
New		35 41	80 30	May 2, 1916	1 53	67 41	21733	W. M. Hill.
Morganton	Burke							
New		35 44	81 42	May 8, 1916	1 04	67 42	21950	W. M. Hill.
Auxiliary		35 45	81 41	May 6, 1916	0 57	67 41		W. M. Hill.
Old		35 45	81 41	May 6, 1916	1 12	67 43	21827	W. M. Hill.
Chapel Hill	Orange							
New		35 55	79 03	April 27, 1916	2 26	68 32	21011	W. M. Hill.
Old		35 55	79 03	April 26, 1916	1 40	68 09	21423	W. M. Hill.
Graham	Alamance							
New		36 04	79 25	May 21, 1915	3 03	68 09	21498	F. Neumann.
Halifax	Halifax							
New		36 20	77 35	April 22, 1916	3 35	68 37	20866	W. M. Hill.
Old		36 20	77 35	April 20, 1916	3 40	68 30	20768	W. M. Hill.

If these observations are made at new stations, the magnetic observers are instructed to mark every station in as permanent a manner as possible, either with a stone or a post of some durable wood, so that it may be available for future occupation. Wherever possible there is used a stone post about three feet long and six inches square, set so as to project two or three inches above the ground. In the center of the top is set a circular brass plate three and one-half inches in diameter, lettered "Magnetic Station United States Coast and Geodetic Survey, Washington, D. C. For information, write to superintendent. Two hundred and fifty dollars fine or imprisonment for disturbing this mark."

If the local authorities at these new observation stations desire it, and are willing to bear the expense, a second stone is erected to mark the true meridian.

They are also required to furnish a sufficiently detailed description to locate the station even if the mark should be destroyed. While only abridged description of these stations is given in the following pages, additional details can be obtained upon application to the superintendent of the Coast and Geodetic Survey, Washington, D. C., so that any one will be able to locate the station. The observer has determined the bearings of two or three prominent objects in addition to the one used as reference mark in the azimuth and declination observations.

There is given below descriptions of the stations from which the observations were made in 1915 and 1916.

INTENSITY OF GRAVITY

The intensity of gravity was determined during 1915 at Greenville, Wilmington, Charlotte, Asheville, and Winston-Salem. Previous determinations had been made at Beaufort, North Carolina, in 1909, and at Durham in 1911. The selection of where the apparatus was set up was as follows:

No. 18, *Beaufort, N. C. (1909)*.—Masonic Hall on Turner Street, one block south of the courthouse; small room near the center of the north side of the basement. The case was mounted on a low concrete pier.

No. 91, *Durham, N. C. (1911)*.—Trinity College, Academic Building, small room in middle of east end of basement. The case was mounted with two bricks under each footplate cemented together and to the concrete floor.

No. 148, *Greenville, N. C. (1915)*.—Proctor Hotel, on the corner of Evans and Third Streets, in Room No. 2 of the higher or back level of the basement, the second room from the steps leading from the lower or front part of the basement on the left side of the hallway. The case was probably mounted on the concrete floor.

No. 149, *Wilmington, N. C. (1915)*.—County courthouse at the intersection of Third and Princess Streets, in a room in the basement once used as a storeroom for disinfectants by the city health officer. It is on the side of the basement toward Princess Street and the last room but one on the left side of the corridor at right angles to Third Street. The case was mounted with two bricks under each footplate cemented together and to the concrete floor.

No. 151, *Charlotte, N. C. (1915)*.—United States assay office, in a small room in the east corner of the basement. The case was probably mounted on the concrete floor.

No. 152, *Asheville, N. C. (1915)*.— Post office, in the northeast corner room of the basement which has two small windows opening on Haywood Street. The case was mounted with two bricks under each footplate cemented together and to the concrete floor.

No. 154, *Winston-Salem, N. C. (1915)*.—High School on Cherry Street at the head of Third Street, in the southwest corner of the basement in a room used as a storage room. The case was probably mounted on the concrete floor.

The results obtained in making the intensity of gravity determinations are given in the following table:

PRINCIPAL FACTS FOR GRAVITY STATIONS IN NORTH CAROLINA.

Number and Name of Station	Latitude	Longitude λ	Elevation H	Theoretical Gravity γo	Correction for Elevation	Correction for Topography and Compensation	Computed Gravity at Station g-gc	Observed Gravity at Station g-gc	
	° ′	° ′	*Meters*	*Dynes*	*Dynes*	*Dynes*	*Dynes*	*Dynes*	*Dynes*
18. Beaufort	34 43.1	76 39.8	1	979.706	.000	+.036	979.742	979.729	—.013
91. Durham	36 00.2	78 53.5	126	979.816	—.039	+.014	979.791	979.835	+.044
148. Greenville	35 36.8	77 22.3	17	979.783	—.005	+.019	979.797	979.787	—.010
149. Wilmington	34 14.2	77 56.6	9	979.666	—.003	+.023	979.686	979.663	—.023
151. Charlotte	35 13.8	80 50.8	228	979.749	—.070	+.015	979.694	979.727	+.033
152. Asheville	35 35.9	82 33.3	670	979.781	—0.207	+0.026	979.600	979.603	+0.003
154. Winston-Salem	36 06.1	80 17	284	979.824	—.088	+.012	979.748	979.718	—.030

ADDITIONAL WORK IN NORTH CAROLINA OF THE UNITED STATES COAST AND GEODETIC SURVEY

There has been a certain amount of topographic and hydrographic work carried on in North Carolina during the past two years. In view of the fact that previous surveys in the interior waters of North Carolina were made forty to sixty years ago, the Coast and Geodetic Survey began in 1914, the work of making a comprehensive resurvey of Albemarle and Pamlico sounds in order to furnish up-to-date data for the increased traffic that might be expected in these regions by reason of the purchase by the Government of one of the canals leading southward from Norfolk and the extensive improvements of the inland waterway from Norfolk to Beaufort begun by the Federal Government at that time.

Topographic Work

There has been completed a revision of the shore line of Albemarle Sound with the exception of the following tributaries: Pasquotank River and Roanoke and Croatan sounds. A resurvey has been made of the easterly half of Pamlico Sound from the north and of Core Sound to and including Hatteras Inlet.

The topography, including the shore line of the above named localities, has been completed.

NATURAL HISTORY

Under this head the State Survey is preparing a series of volumes on the Natural History of North Carolina. The first volume published was on the "Fisheries of North Carolina," which appeared in 1907 as Volume II of the Survey's Reports.

The next volume which was on "The Birds of North Carolina," was being printed when it was entirely destroyed by the fire which burned the plant of E. M. Uzzell & Co. Preparations, however, were immediately begun for reprinting this volume. Through the generosity of the State Audubon Society, sufficient funds were appropriated with which to have the drawings re-made. A page proof of the book was in the Survey office and this will be used as a manuscript for the printer.

Another volume in this Natural History series, which will be of peculiar value to the people of North Carolina, is on "The Mushrooms of North Carolina." Particular emphasis is given in this volume to the commercial or edible mushrooms.

Other volumes that will be prepared are:

"Trees of North Carolina"
"Medicinal Herbs of North Carolina"
"Ferns of North Carolina"
"Insects of North Carolina"
"Mammals of North Carolina"

EXHIBITS

It has been found that very effective advertising of the State's resources can be made by exhibits at Fairs, Conventions, etc., and during the past two years several exhibits have been made both within and without the State. It is believed that this work of the Survey should be extended as much as possible.

EXHIBITS AT STATE FAIRS

At the State Fairs of 1915 and 1916 the Survey has made such exhibits of the State's natural resources as was thought would be of educational value to the people of the State and also of commercial value to those interested in investment in this State.

State Fair of 1915

The Survey exhibit at this Fair was located in Machinery Hall and consisted of displays representing our principal mineral resources (including structural materials, such as building and ornamental stones and brick). The principal minerals displayed were samples of gold, copper, iron, corundum, chromite, tin minerals, mica, talc, soapstone, gem minerals, monazite, zircon, rhyolite, etc. The minerals which were especially emphasized in this exhibit were gold ore, from the Rich Cog Mine in Montgomery County, furnished by Mr. R. P. Richardson, of Reidsville; copper ore from Jackson County; iron ores from Avery County, furnished by the Cranberry Furnace Company; feldspar, mica, and specimens of quartz and uranium ores, furnished by the Carolina Mineral Company of Penland, Mitchell County; and samples of common and pressed brick. Building and ornamental stones were exhibited in the shape of curbing of gray granite, from the North Carolina Granite Corporation, Surry County; and a large cube of blue granite cut to show its monumental possibilities, furnished by the Blue Pearl Granite Company of Winston-Salem. Polished spheres of gray, blue, and pink granite were shown, and also a sphere of white marble from Mitchell County. This marble is of an exquisite whiteness and grain, comparing most favorably with the Italian marbles, and could undoubtedly be used for sculpture. Boxes of shell marl were displayed, illustrating its value for agricultural purposes and its use as a chicken grit. There were also exhibited samples of North Carolina kaolin and specimens of art pottery made by the Nonconnah Art Pottery Company of Skyland, from North Carolina clays.

In addition to the minerals, there were photographs, maps, charts, etc., relating to the mineral and timber resources of the State and illustrating the drainage work.

The Survey coöperated with the State Highway Commission in a road exhibit, consisting of photographs, maps, charts, road surfacing materials, models, etc. In this exhibit the two State departments also had the coöperation of the United States Office of Public Roads and Rural Engineering, which furnished an excellent series of models illustrating sections of the various types of road pavements.

In addition to the above, there was also displayed in the Survey space an exhibit of harmful drugs and patent medicines, with labels attached, warning the public as to their indiscriminate use; and of colored charts giving food values of thirty-two samples of infants' foods. This exhibit was sent to the Survey by the Bureau of Chemistry of the United States Department of Agriculture.

State Fair of 1916

In preparing for the 1916 Fair, the Survey sent out many letters inviting producers of minerals, mineral waters, structural materials (including granite, limestone, sandstone, brick, tile, etc.) to participate by sending samples of their materials for display. As a result of this correspondence, the following exhibits were received from the producers: Specimens of gray granite curbing, crushed stone (sized), etc., from the North Carolina Granite Corporation, of Surry County; specimens of quartz for flux in copper smelting from the North Carolina Flux Company, of Cherokee County; samples of feldspar, mica, quartz, uranium minerals, etc., from the Carolina Mineral Company, of Mitchell County (unfortunately this exhibit was stolen from the space before it could be exhibited); mineral waters from the Buckhorn Lithia Springs of Granville County, Moore's Springs of Moore County, Jackson Mineral Springs of Moore County, Fuquay Springs of Wake County, and Panacea Springs of Warren County; and specimens of cement tile from the Mattamuskeet Cement Products Company of Hyde County. Samples of common and pressed brick were received from the Tar River Brick Company of Rocky Mount, Clark Brick Company of Wilson, and Johnson & Johnson of Raleigh.

In addition to the above, there were exhibits of talc from the North Carolina Talc and Mining Company; mica from the Tar Heel Mica Company of Plumtree; chromite, tin ore, kaolin, corundum, monazite, graphite, gem minerals, etc.

There was a large mineral chart giving the production of the various North Carolina minerals for 1915 and the three years preceding, a map showing various mineral localities, photographs of mines and quarries, etc.

The drainage work was illustrated similarly as in 1915, with photographs of drainage districts before and after drainage, maps, charts, pamphlets, etc.

The forestry exhibit is described on page 87, under Forestry.

The Survey also coöperated with the State Highway Commission in an exhibit of road photographs, maps, charts, road materials, etc., referred to on page 104.

OTHER EXHIBITS

In addition to the State Fairs, exhibits were made at a number of other fairs, conventions, etc., as follows:

1915. Road Institute held at the University of North Carolina, February 23-27—Road.
1915. Georgia Drainage Congress, Albany, Georgia, May 13—Drainage.
1915. National Drainage Congress at San Francisco, September—Drainage.
1915. Anson County Fair at Wadesboro, October—Roads, Forestry.
1915. Mecklenburg County Fair, Charlotte, October 26-27—Roads.
1915. Robeson County Fair, Lumberton, November—Roads, Forestry.
1915. North Carolina Drainage Convention, Belhaven, November 29, 30-December 1—Drainage.
1916. Social Service Conference, Charlotte, January 21—Forestry.
1916. North Carolina Forestry Convention, New Bern, January 25-26—Forestry.
1916. Third Road Institute, Chapel Hill, N. C., February 7-12—Roads.
1916. Wayne County Fair, October 15—Roads, Forestry.
1916. Orange County Fair, Hillsboro, October 25-26—Roads.
1916. Rally Day at Chapel Hill, N. C., November 3—Roads, Forestry, Drainage, Minerals.
1916. Bladen County Fair, Clarkton, November—Drainage.
1916. North Carolina Drainage Convention, Greensboro, November 22-23—Drainage.

PUBLICATIONS

During the two years 1915 and 1916, the following publications have been issued by the North Carolina Geological and Economic Survey, which embody the results of the investigations that have been outlined above, and to which references have been made:

Volumes

Volume IV. Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley, and H. H. Brimley, 1914. This volume was ready for binding when it was destroyed in the fire which burned the plant of E. M. Uzzell, Public Printer, in November, 1915.

Bulletins

Bulletin 25. Zircon, Monazite, and Other Minerals Used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916.

Economic Papers

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the departments of Civil and Highway Engineering of the University of North Carolina and the North Carolina Geological and Economic Survey.

40. Forest Fires in North Carolina During 1914, and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915.

41. Proceedings of the Seventh Annual Drainage Convention of the North Carolina Drainage Association, held at Wilson, North Carolina, November 18-19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915.

42. Organization of Coöperative Forest Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915.

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary, 1916.

Biennial Reports

Biennial Report of the State Geologist, 1913-1914. Joseph Hyde Pratt, State Geologist, 1915.

Special Publications

Arbor and Bird Day Manual for North Carolina, 1915. Compiled for use in the public schools by the North Carolina Geological and Economic Survey. Issued by the office of the Superintendent of Public Instruction, 1916.

The following leaflets have been prepared by the North Carolina Geological and Economic Survey, and printed by the North Carolina Forestry Association:

Prizes for State Forestry Exhibits.

Pertinent Paragraphs Concerning the Eastern Carolina Forests and the North Carolina Forestry Association.

School Contests in Forestry: Prize Essay Competition; School Forestry Exhibits; a Nature Study Contest.

Good Roads Circulars

104. Decision of the Supreme Court Regarding Road Bonds. June 30, 1915. 57 pp.

105. Statistics Regarding Road Work in North Carolina During 1914. July 5, 1915. 2 pp.

106. Annual Convention of the North Carolina Good Roads Association, held at Asheville, N. C., July 14-16, 1915. July 10, 1915. 3 pp.

SPECIAL

Highway Commission Bill recommended by the Legislative Committee of the North Carolina Good Roads Association.

Press Bulletins

During the past two fiscal years, Press Bulletins 137 to 153 have been published and distributed by the North Carolina Geological and Economic Survey. These Press Bulletins discuss various questions relating to Forestry, Drainage, Mining, etc., and have been issued in order to give to the people of the State a comprehensive idea of the work that the Survey is doing, also in order to bring before the people at once certain information that the Survey has collected upon some particular subject. The Press Bulletins also call attention to the more detailed reports that the Survey is publishing as Bulletins and Economic Papers. The newspapers quote freely from these Press Bulletins, and in this way the information collected by the Survey is given more general circulation.

The following is a list of the Press Bulletins published during the past two years:

137. Our Forest Fire Record. December 31, 1914. 2 pp.
138. Mount Mitchell State Forest: Opinions of Representative Men as Expressed at the Convention of the North Carolina Forestry Association, Raleigh, N. C., January 13-15, 1915. February 2, 1915. 5 pp.
139. Forest Fire Protection Demanded by the Thinking Public: Opinions of Representative Men as Expressed at the Convention of the North Carolina Forestry Association, Raleigh, N. C., January 13-15, 1915. February 6, 1915. 6 pp.
140. What the Forests of North Carolina Mean to Her Citizens, and Why They Should be Preserved. February 6, 1915. 5 pp.
141. Forestry in North Carolina: Further Extracts from the Proceedings of the North Carolina Forestry Association. February 24, 1915. 6 pp.
142. Demonstration Forests for North Carolina. February 27, 1915. 4 pp.
143. Timber Resources of Franklin County. April 10, 1915. 4 pp.
144. Timber Resources of Wake County. April 15, 1915. 4 pp.
145. Timber Resources of Chatham County. May 10, 1915. 4 pp.
146. Timber Resources of Lee County. May 12, 1915. 4 pp.
147. Forestry Laws of North Carolina. May 27, 1915. 17 pp.
148. Suggestions Regarding Arbor Day Program. July 10, 1915. 3 pp.
149. Loblolly or North Carolina Pine. August 25, 1915. 2 pp.
150. Mineral Production in North Carolina During 1914. September 1, 1915. 3 pp.
151. A Year of Progress in Forestry in North Carolina. January 1, 1916. 4 pp.
152. North Carolina's Forestry Laws. March 1, 1916. 10 pp.
153. Amendment to the North Carolina Drainage Law by the General Assembly of 1915. April 15, 1916. 11 pp.

Press Notices

In connection with the work of the Survey and the various associations with which it coöperates, it has been found necessary to send to

the papers of the State short notices in regard to various conventions and other work which is being undertaken. These notices cover anywhere from a paragraph to a page and are sometimes sent simply to the daily papers, but frequently to all the press of the State. These notices have been gotten out first on a duplicating machine, which proved inadequate; and in order to facilitate the work, in July, 1916 the Survey purchased a multigraph equipment, which has added to the ease and efficiency of this line of work. During the past two years the Survey has issued and distributed forty-three press notices.

REPORTS PREPARED BUT NOT PUBLISHED

In addition to the above, the following reports have been prepared, and are in the hands of the Public Printer. They have not been printed, according to the Commission of Labor and Printing, on account of lack of funds.

The investigations were authorized by the General Assembly of North Carolina, the reports contained the results of these investigations; the people of the State desire these results, and capitalists and investors outside the State desire them. Arrangements should be made for their publication.

Bulletins

26. A report on the Virgilina Copper District.

Economic Papers

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary.
45. Proceedings of the Eighth Annual Drainage Convention, held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. Prepared by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary.

Press Bulletins

154. Giving Decision of the Supreme Court Relating to Drainage.
155. Decision of the Supreme Court Relating to Drainage.
156. A Report Relating to the "Ash in North Carolina."

Volumes

IV. Birds of North Carolina. Funds are not yet available for the publication of this volume.

The value of the publications of the Survey is indicated by the attached letters:

(Copy)

THE INTERSTATE INVESTMENT AND DEVELOPMENT COMPANY

CLEMENT L. WEBSTER, *President*

CHARLES CITY, IOWA, January 25, 1915.

PROF. JOSEPH HYDE PRATT,
State Geologist,
Chapel Hill, N. C.

DEAR SIR:—I have just received a copy of your Economic Paper No. 34, The Mining Industry of North Carolina for 1911-1912, for which please accept sincere thanks. The publications of your Survey are proving the best advertisement of the natural resources of your State it could possibly have, and should be practically appreciated by its people.

Yours faithfully, CLEMENT L. WEBSTER.

(Copy)

4920 LOCUST ST., PHILADELPHIA, PA., January 23, 1915.

DR. JOSEPH HYDE PRATT,
Chapel Hill, North Carolina.

DEAR SIR:—I desire to thank you for a copy of your report on the Mining Industry of North Carolina for 1911-1912, which I had the pleasure of receiving a few days ago. It is an exceptionally interesting and complete work, and will surely be of great service in acquainting and interesting people outside of your State (as well as in it) in the abundant and varied deposits in the Old North State.

Again thanking you, I remain,

Yours sincerely, JOHN H. ROTHROCK.

ADDITIONAL PUBLICATIONS OF THE STATE GEOLOGIST

In addition to the reports the State Geologist has prepared for the State Survey, he has also published several articles in different magazines and papers throughout the country, which have helped to advertise the mineral resources of the State and its industrial development. The articles published during the past two years have been as follows:

Competent Highway Engineers Directing in North Carolina. "Manufacturers' Record," October 22, 1914, Vol. LXVI, p. 58.

Convict Labor in Road Construction. Proceedings of the Eleventh Annual Convention of the American Road Builders' Association, December, 1914.

The North Carolina Drainage Law: An Outline of the provision of the law that has made North Carolina a leader among Southern States in drainage work, and the organization of the drainage district. "Progressive Farmer," November 12, 1914.

Educational Field for Highway Department. "Manufacturers' Record," November 12, 1914, Vol. LXVI, p. 53.

The Old and New Attitude of the State Toward Its Prisoners. With Dr. W. S. Rankin, in Proceedings of the Southern Sociological Congress held at Houston, Texas, May 8, 1915.

Reclamation of the Swamp and Overflowed Lands of North Carolina. "Progressive Farmer."

The Coggin (Appalachian) Gold Mine. Journal of the Elisha Mitchell Scientific Society, Vol. XXX, No. 4, March, 1915.

Certain Magnetic Iron Ores of Ashe County, North Carolina. Journal of the Elisha Mitchell Scientific Society, Vol. XXX, No. 4, March, 1915.

Annual Meeting of the North Carolina Good Roads Association. "Southern Good Roads," Vol. XII, No. 2, August, 1915.

The Southern Appalachian Good Roads Association. "Southern Good Roads," Vol. XII, No. 3, September, 1915.

Proceedings of the Seventh Annual Drainage Convention held at Wilson, N. C., November 18 and 19, 1914. Economic Paper No. 41 of the Publications of the N. C. Geological and Economic Survey.

Statistics Regarding Road Work in North Carolina During 1914. Good Roads Circular No. 105 of the N. C. Geological and Economic Survey.

North Carolina's Interest in the Construction of Public Roads. "Southern Good Roads," Vol. XII, No. 4, October, 1915.

The Merit System in Highway Work. "Southern Good Roads," Vol. XII, No. 5, November, 1915.

Report to the Supreme Court of the United States on the North Carolina-Tennessee Boundary Line. Published, 1916.

Third North Carolina Road Institute at the University, February 7-12. "Southern Good Roads," Vol. XIII, No. 2, February, 1916.

Reclamation of Swamp and Overflowed Lands in North Carolina. "Manufacturers' Record," March 23, 1916.

Memorial Sketch of Joseph Austin Holmes. Journal Elisha Mitchell Scientific Society, Vol. XXXII, No. 1, April, 1916.

Gold Mining in the Southern Appalachian Region. "Manufacturers' Record," May 4, 1916.

National Forestry Convention in South. "Manufacturers' Record," June 8, 1916.

North Carolina Good Roads Convention: Summary of Work Done and Topics Discussed in Gathering at Wrightsville Beach. "Southern Good Roads," Vol. XIII, No. 6, June, 1916.

High Grade Construction of the Asheville-Weaverville Highway. "Manufacturers' Record," August 31, 1916.

Southern Appalachian Good Roads Association: Eighth Annual Convention at Lexington, Kentucky, September 5-8, 1916.

Utilizing Our Raw Materials at Home. "Manufacturers' Record," September 14, 1916.

Great Interest in Appalachian Road Construction. "Manufacturers' Record," September 21, 1916.

Surry County, North Carolina, Roads. "Southern Good Roads," Vol. XIV, No. 3, September, 1916.

Hillsville, Virginia, Road Meeting. "Southern Good Roads," Vol. XIV, No. 3, September, 1916.

Wilmington-Goldsboro Highway. "Southern Good Roads, Vol. XIV, No. 4, October, 1916.

Eighth Annual Convention of the Southern Appalachian Good Roads Association. "Southern Good Roads," Vol. XIV, No. 4, October, 1916.

Development of Highway Building in North Carolina. "Charlotte Observer," Land and Industrial Edition, October 26, 1916.

Mineral Resources of North Carolina, An Asset of Big Value. "Charlotte Observer," Land and Industrial Edition, October 26, 1916.

North Carolina Forests Represent a Large and Important State Asset. "Charlotte Observer," Land and Industrial Edition, October 26, 1916.

Monazite. "Mineral Industry," Vol. XXIV, pp. 532-540.

ADDRESSES OF STATE GEOLOGIST

The State Geologist has been called upon to make addresses not only in North Carolina, but before many National Associations in different parts of the country. Most of the addresses outside of the State have had a direct bearing upon some problem relating to our natural resources and applicable to conditions in North Carolina. There is given below a list of the addresses made by the State Geologist, together with the date and place.

Reclamation of North Carolina Swamp Lands. Address at Bolton, N. C., November 6, 1914.

Road Publications and Publicity. Address before the American Road Congress, Atlanta, Ga., November 9, 1914.

Development of Reclaimed Swamp Lands. Address at the Corn Show, Wilmington, N. C., November 13, 1914.

Presidential address before the North Carolina Drainage Association, Wilson, N. C., November 18, 1914.

The Southern Transcontinental Highway. Address delivered before Road Convention at Newport, Tenn., November 21, 1914.

Economics of Good Roads. Address at "County Day Celebration," Hillsboro, N. C., December 5, 1914.

Address before the American Association of State Geologists at Philadelphia, December 29, 1914.

What the Forests of North Carolina Mean to Her Citizens and Why They Should be Preserved. Address delivered at the Fifth Annual Convention of the North Carolina Forestry Association, Raleigh, N. C., January 13, 1915.

Bond Issue for Good Roads. Address at Good Roads Meeting at Sanford, N. C., January 14, 1915.

Address before St. Mary's School, Raleigh, January 21, 1915.

Purposes of the Good Roads Institute. Address before the Second Good Roads Institute, University of North Carolina, February 23, 1915.

Chapel talks before students of the A. and M. College, Raleigh, N. C., March 2, *Transportation;* March 3, *Highways of North Carolina;* March 4, *Resources of North Carolina.*

Fisheries Legislation. Address before National Association of Shellfish Commissioners at New Orleans, La., March 17, 1915.

Address before State Fisheries Commission, New Bern, N. C., April 15, 1915.

Conservation of Our Natural Resources. Address before the State Federation of Women's Clubs, Goldsboro, N. C., May 5, 1915.

Attitude of a State Towards Its Prisoners. Address before the Southern Sociological Congress, Houston, Texas, May 10, 1915.

Reclamation of Swamp and Overflowed Lands. Address before the Georgia Drainage Congress, Albany, Ga., May 13, 1915.

Economic Value of Transcontinental Highways to the Tourist Trade. Address before meeting of Denver and Colorado Springs Automobilists, Denver, Colo., June 12, 1915.

The Development and Conservation of the Natural Resources of North Carolina. A series of lectures delivered before the Summer School of the University of North Carolina, June 30-July 13, 1915.

Conservation and Forestry. Address before the North Carolina Forestry Association, Montreat, N. C., July 8, 1915.

Address before the North Carolina Good Roads Association, July 14, 1915.

Bond Issue for Road Construction. Address at Brevard, N. C., August 4, 1915.

Maintenance of Public Roads. Address at Ellenboro, N. C., August 10, 1915.

Economic Value of Good Roads and How to Obtain Them. Address at Clarkton, N. C., August 12, 1915.

The Merit System in Highway Work. Address before the Pan-American Highway Congress, Oakland, Cal., September 16, 1915.

Drainage Areas of the South Atlantic States and Their Reclamation. Address before the National Drainage Congress, San Francisco, Cal., September 20, 1915.

Presidential address before the Southern Appalachian Good Roads Association, Bluefield, W. Va., October 14, 1915.

Illustrated lecture before Civics Department of Woman's Club, Charlotte, N. C., November 5, 1915.

Address before Good Roads meeting at Bear Wallow, N. C., November 6, 1915.

Bond Issue for Good Roads. Address at Liberty and Cowee, Macon County, N. C., November 9, 1915.

The Bond Issue and Good Roads. Address at Oak Grove, Macon County, N. C., November 10, 1915.

The Selection of Materials for Highway Construction. Address before International Road Congress, Worcester, Mass., December 16, 1915.

Address at Portland, Me., before Annual Meeting of Maine Automobile Association, December 20, 1915.

Memorial Address on Joseph Austin Holmes before Geological Society of America, Washington, D. C., December 28, 1916.

Lectures before Road Institute of West Virginia at the University of West Virginia, Morgantown, West Virginia, January 13, 1916. Subjects: (1) *Top-soil and Sand-Clay Roads;* (2) *Road Publications;* (3) *Uniform Road Legislation.*

Forest Conservation in North Carolina. Address before North Carolina Forestry Association, New Bern, N. C., January 25, 1916.

Need of Appalachian Forest Reserves. Talk before Agricultural Committee of House of Representatives, Washington, D. C., January 28, 1916.

Lectures at Road Institute at University of Tennessee, Knoxville, Tenn., February 16, 1916. Subjects: (1) *Selection of Road Surfacing Materials;* (2) *Maintenance of Roads.*

Maintenance and Upkeep of Roads. Address before Annual Meeting of Asheville Motor Club, Asheville, N. C., February 18, 1916.

Forests and Trees. Address before Fortnightly Club, Raleigh, N. C., February 28, 1916.

Our Country's Highways. Address at Albemarle, N. C., before meeting held in interest of Charlotte-Pinehurst Highway, March 9, 1916.

Memorial Address on Joseph Austin Holmes before Elisha Mitchell Scientific Society, Chapel Hill, N. C., March 14, 1916.

Maintenance of Highways. Address before Greensboro Chamber of Commerce, March 23, 1916.

Maintenance of Highways. Addresses delivered at Morehead City and New Bern, N. C., April 12, 1916.

Maintenance of Highways. Address at Kinston, N. C., April 13, 1916.

Maintenance of Highways. Address at Goldsboro, N. C., April 13, 1916.

Maintenance of Highways. Addresses at Smithfield and Durham, April 14, 1916.

Maintenance of Highways. Address at Hillsboro, N. C., April 17, 1916.

Fisheries Legislation. Address before National Association of Fisheries Commissioners at Wilmington, N. C., April 18, 1916.

The Courtesy of the Highway. Address before Asheville Motor Club, April 24, 1916.

Magnetic Separation of Minerals. Address before North Carolina Academy of Science, Raleigh, N. C., April 28, 1916.

Maintenance of Highways. Address before the North Carolina Division of the Travelers Protective Association of America, Henderson, N. C., May 5, 1916.

Short talk at Southern Forestry Congress, Asheville, N. C., July 11, 1916.

Address before Engineer Company of the National Guard, Wilmington, N. C., July 19, 1916.

Women's Part in the Good Roads Movement. Address at County Meeting of Women's Clubs and Other Organizations, Oxford, N. C., July 21, 1916.

Bond Issue for Good Roads. Address at Brogden Schoolhouse, Boon Hill Township, Johnston County, N. C., August 2, 1916.

Maintenance of Roads. Address before Asheville Motor Club, August 7, 1916.

National Highways. Address at Hillsville, Va., August 10, 1916.

Federal Aid Road Law. Address before American Association of State Highway Officials at Washington, D. C., August 15, 1916.

State Highways and Bond Issues. Address at Riggsbee, Chatham County, N. C., August 29, 1916.

Presidential Address before Southern Appalachian Good Roads Association at Lexington, Kentucky, September 5, 1916.

Wilmington-Goldsboro Highway. Address at Warsaw, N. C., September 20, 1916.

State Highways. Address at Elkin, N. C., September 25, 1916.

Need of Good Roads in Alleghany County. Address at Sparta, N. C., September 26, 1916.

Need of Good Roads in Ashe County. Address at Jefferson, N. C., September 27, 1916.

Federal Aid in Road Construction. Address at State Fair, Raleigh, N. C., October 18, 1916.

EXAMINATION OF MINERAL SPECIMENS

The North Carolina Geological and Economic Survey desires to call the attention of mining men, prospectors and others to the fact that it is not equipped for making assays or chemical analyses of minerals or rocks. Many specimens and samples are received by the Survey, accompanied by requests for such treatment, with which it is impossible to comply, as we have no appropriation for this purpose. The most the State Geologist can do is to make a mineralogical examination of the mineral, and to give an offhand opinion based on a simple examination of the specimen as to its value.

A great many samples received prove to be iron pyrites or "fools' gold," the shiny particles being taken by the writers for gold. Many of the other specimens are only quartz.

If an assay is desired, the proper course is to employ a private assayer or to send a specimen to one of the government assay offices, where a regular charge is made for such work. When specimens are sent to the Survey, applicants should be particular to state whether they wish them returned, as otherwise they will be destroyed. Mr. Frank P. Drane, of Charlotte, N. C., does what chemical work the Survey has done.

ADMINISTRATIVE

There are certain phases of the work of the Survey that can not very readily be brought under any of the previous headings and are included under the head of Administrative.

The State Geologist, as authorized by the Geological Board, has taken an active part in the work of several National and State organizations where work is along similar lines to those of the different divisions of the Survey.

The State Geologist is:

President of the Southern Forestry Congress, having been elected to this office July, 1916.

Member of the Executive Committee of the North Carolina Forestry Association, 1915-17.

Secretary of the American Association of State Highway Officials. Re-elected at its annual meeting in St. Louis, Mo., December 6, 1916.

Vice-President of National Highways Association.

Director of the American Association for Highway Improvement.

President of the Southern Appalachian Good Roads Association, 1909-1916.

Secretary of the North Carolina Good Roads Association.

Member of the Executive Committee of the National Association of Fisheries Commissioners, 1914-1917; President, 1912-1913.

Member of the Executive Committee of the American Association of State Geologists, 1915-1917.

Member of Board of Governors of the National Drainage Congress, 1914-1916.

Secretary of the North Carolina Drainage Association, 1908-1911; President, 1911-1912; Secretary, 1912-1917.

Member of the Legislative Committee of the American Mining Congress.

The State Geologist was appointed by the Secretary of the Navy one of the State Directors of the organization for Industrial Preparedness and an associate member of the Naval Consulting Board of the United States. While this work requires some time of the State Geologist it is in accord with the object of the Survey.

The following letter was received from President Graham of the University and explains itself:

PRESIDENT'S OFFICE
THE UNIVERSITY OF NORTH CAROLINA
CHAPEL HILL

July 7, 1915.

MY DEAR JOSEPH:—Please convey to the Geological Board the assurance of our appreciation and gratitude for the specimens of "radium" that the Survey has turned over to our Department of Chemistry. It will be of fine service to us, and is especially appreciated, owing to the fact that we could not have secured it by any other means.

Faithfully yours,

(Signed) EDWARD K. GRAHAM,
President.

DR. JOSEPH HYDE PRATT,
State Geologist,
Chapel Hill, North Carolina.

The Foster Bill which had been introduced into Congress calling for the establishment of mining experimental stations, and rescue stations to be operated by the United States Bureau of Mines, was approved by the Association of State Geologists and the American Mining Congress, and these two Associations assisted in every way possible to obtain its passage by Congress. As a result of the work of the Association of State Geologists, the American Mining Congress (of which the State Geologist is a member of the Legislative Committee), and other associations, the Foster Bill was enacted into law by Congress just before its adjournment, March 3, 1915. This bill calls for the establishment of three mining experimental stations each year until ten shall have been established. In the general plan of the Bureau of Mines, one district in which an experimental station should be established consists of Virginia, North Carolina, South Carolina, Georgia and Florida. It was the

expectation and desire of the former Director of the Bureau of Mines, Dr. J. A. Holmes, that the station for this district should be established in this State. A conference between the State Geologist and the former Director of the Bureau of Mines, just before his death, was held at Denver, Colorado, June 11, 1915, in regard to the establishment of a station in this district.

As a member of the Executive Committee of the National Association of Fisheries Commissioners, the State Geologist attended a meeting of this committee at Baltimore, Maryland, when it was called in conference with several members of Congress in connection with national fisheries legislation. This association has been of very material help to the State in assisting the State Geologist in creating the sentiment favorable to State-wide fisheries legislation.

At the annual meeting of the National Association of Fisheries Commissioners at New Orleans, March 17-19, 1915, the State Geologist made an address on fisheries legislation. While in attendance at the Convention, he had a conference with Dr. Darlton Bates, of the United States Bureau of Chemistry, and made arrangements with him for an investigation of the oyster bottoms of North Carolina. This matter has now been referred to the new Fisheries Commission and it is hoped that they will avail themselves of this opportunity for a thorough investigation of the oyster bottoms. The only cost to the State is the furnishing of the boats necessary for transporting the investigators. They have a car laboratory that they can place in North Carolina which has ample laboratory facilities for the examination of the samples collected.

The State Geologist was instrumental in having the Eighth Annual Meeting of the National Association of Fisheries Commissioners held at Wilmington, N. C., April 18-20, 1916, at which the Secretary of Commerce, William C. Redfield, made an address.

JOSEPH AUSTIN HOLMES
STATE GEOLOGIST OF NORTH CAROLINA, 1891-1905

Joseph Austin Holmes, who was State Geologist of North Carolina from 1891 to 1905, died at Denver, Colorado, July 13, 1915. On account of the valuable work that he did for North Carolina and his continued interest in the development of the State, the present State Geologist has felt that he would like to honor the name of Dr. Holmes by giving in this report a short memorial sketch of him.

MEMORIAL SKETCH
OF
DR. JOSEPH AUSTIN HOLMES

By Joseph Hyde Pratt, State Geologist of North Carolina

The life of Dr. Joseph Austin Holmes was devoted to the development and welfare of his country, and in his death the people of the United States have lost one of their most efficient and valuable public servants. He was a man who put duty first, and, in carrying out this ideal he gave his life in an endeavor to improve the condition and safety of the miners. He did not know the word "failure;" and, where other men would have failed, he has been able to accomplish the results desired. It is granted to but few men to be able in the few years of their life's activity to do that which will leave a permanent influence and impress upon an industry; but to Dr. Holmes, whose life we are now commemorating, this distinction was allotted.

Due almost entirely to his energy and efforts, there has been created throughout this country an organized movement looking to the preservation of human life; and, although his first work was directed toward the prevention of mine accidents and safety and welfare of the hundreds of thousands of men who daily risk their lives in the production of fuel so necessary to the nation's industry and commerce, it developed the "safety first" idea that has spread to nearly every industry and into all walks of life. These words are almost synonymous with the word "Holmes" and, wherever we see "safety first," we are reminded of the wonderful achievements of this man. He has not only left his impress upon an industry but has also created an organization which will live as long as our government exists and is a monument to the tireless energy, public spiritedness and unselfishness of the man who is responsible for its creation. I refer to the Bureau of Mines whose foundation he laid by many feats of exacting labor and fruitful work, and who, by masterful generalship and arguments, as he only could use, carried the bill to establish the Bureau of Mines successfully through an unsympathetic Congress.

To Dr. Charles D. Walcott, former Director of the United States Geological Survey and now Secretary of the Smithsonian Institution, must be given the credit of recognizing those qualities of character and ability in Mr. Holmes which he realized were necessary to a man who could not only lay the foundation and build up an organization that would lead to a Bureau of Mines, but who would also be able to direct it after its creation. In a recent communication from Dr. Walcott, he wrote:

"About 1900 it became more and more evident that he (Dr. Holmes) was a man of broad conceptions and fitted to undertake work of national scope and it was with great pleasure that I learned in 1904 that he was willing to give all of his time and energy to the development of the Section of Mines and Mining in the Federal Survey. I told him that as soon as the work was sufficiently well organized it would be made a Division of the Survey and undoubtedly lead to the creation of a Bureau of Mines and Mining. He entered into the work with a zeal and intelligence that was not fully understood by his immediate associates, but the work steadily grew, and in 1910 he was appointed Director of the Bureau of Mines."

His appointment, however, was not obtained without very severe opposition from a secretary who was hostile to Dr. Holmes, and it is rumored that this important position was offered to several other men; but, to the credit of the men of science of this country, it can be said that they all refused to accept what all knew rightfully belonged to another. Those who knew Dr. Holmes, having confidence in his ability and believing that he was the logical head for the new Bureau, were persistent in their demand that he should receive the appointment. It is not generally known how near the Bureau came to losing Dr. Holmes as its director, and how near the University of West Virginia came to securing him as its president; and, as an incident bearing on this is illustrative of the loyalty of Dr. Holmes' friends, I wish to quote in part a few lines from a letter I recently received from Dr. I. C. White, State Geologist of West Virginia:

"It was during this discouraging period of his life, just before the appointment of a Director of the Bureau of Mines, when he had given up all hope of receiving the appointment, that he came up from Pittsburgh to spend the week-end at the writer's home in Morgantown, W. Va. He was weary and care-worn from the long and disappointing vigil, but gentle and loving as ever. No word of reproach or bitterness escaped his lips. If he could not serve his country in an edifice his own hands had so largely constructed, he was ready to give his services to a State that had stood by him in his long battle, and where he knew he would be among appreciative friends. The State University of West Virginia was seeking a president and one of the purposes of Dr. Holmes' visit to my home was to acquaint the writer, who had ever been his trusted friend, with the fact that he had despaired of being appointed Director of the United States Bureau of Mines, and would accept the presidency of the University of West Virginia if the Regents of the same would make the tender."

Fortunately for the industry, Dr. White and others, realizing that for the success of the Bureau of Mines it was necessary that Dr. Holmes

should be its head, decided out of genuine loyalty to him and appreciation of his work, that they would not place his name for action before the Regents of the University until President Taft had actually bestowed the Directorship of the Bureau of Mines upon someone else. His friends' belief in what President Taft would finally do was confirmed a few days later when the appointment of Dr. Holmes was announced from the White House.

That he was a wise selection is evidenced by the wonderful development of the Bureau under his administration. The work he had planned as Chief of the Technologic Branch of the United States Geological Survey developed rapidly, aided by Congress, which widened the scope and enlarged the purposes of the Bureau. The principal investigations taken up under Dr. Holmes' directorship and the results accomplished are as follows:

An investigation in regard to the improper use of explosives and the use of improper explosives.

Investigation in regard to better lights for mines. Result, the establishment of a permissible list of portable electric lamps for use in dangerous mines.

In developing rescue work Dr. Holmes introduced into this country the so-called "oxygen breathing apparatus." Result, such apparatus is now not only widely used in mine-rescue work, but is being adopted by manufacturing plants and by city fire departments. There are today six mine-rescue stations, eight mine-rescue cars, and one rescue motor truck operated by the Bureau of Mines. There are seventy-six mine-rescue stations that have been established by mining companies, at which there are 1,200 sets of artificial breathing apparatus in addition to the auxiliary equipment for first-aid and fire-fighting work. There are also twelve mine-rescue cars being operated by mining companies.

Investigations into the causes of disasters and the recommendations made by the Bureau have resulted in an ever decreasing death rate.

The investigation of coal dust and explosions therefrom was one of the most important lines of investigation that Dr. Holmes took up. The result today is that the entire mining industry, including operators and miners, is convinced that coal dust will explode and recognize the danger from it; and mine operators and State officials are following the recommendations of the Bureau to prevent dust explosions.

Investigations have been conducted regarding smelter smoke wastes and wastes in the treatment of rare minerals and metals. Dr. Holmes emphasized the need of such investigations, indicating that there was at least $1,000,000 a day being wasted or lost in the present methods of mining and utilization of our mineral resources.

Investigations regarding the extraction of radium from its ores have resulted in the development of a process through which it will be possible to greatly reduce the cost of radium compounds to the consumer. "The process is to be patented and dedicated to the public."*

Investigations have been started to reduce the great loss of $75,000,000 annually, due to coking coal in bee-hive ovens. As a result, already some of this loss has been reduced through the use of by-product ovens and the utilization of the by-products obtained.

Dr. Holmes called attention to the annual waste of over $4,500,000 in brass furnace practice and then had prepared a report showing how, by practical means, this waste can be largely prevented.

These are some of the investigations that Dr. Holmes has had taken up by the Bureau of Mines and they illustrate the wide scope of the work he was planning for the Bureau to undertake. Its development into one of the most important of all the Federal Bureaus has been phenomenal and is due not only to the indefatigable work of the Director, but to the fact that he was a splendid judge of men and their capacity for work and was able to surround himself with the type of men who were able to carry out the plans his master mind had conceived; and these men were loyal and true to him.

He was thoughtful and considerate of his associates; and while he may have demanded much of them, he always gave them full credit for work done; and of the reports of the investigations carried out by the Bureau but very few bear his name as author. Credit is given to him who carried on the investigation. Dr. Holmes planned the character of the investigations; then put it up to one of his associates to do the detailed work. What he wanted was results. He had little time to write for publication or to think about personal advancement, and he left it to his associates to do the writing and give him the results—and results he surely obtained.

Although Dr. Holmes is the author of but comparatively few publications; yet he has been personally responsible for the publication of many important scientific and economic papers, because he has had the foresight to open up new fields of investigation and secure the properly trained men to carry on the work he outlined. I doubt if there has ever been a man who surpassed him in this respect.

This faculty of Dr. Holmes showed itself soon after he became State Geologist of North Carolina in 1891. In this position he had wide latitude for planning out a varied line of investigations relating to many subjects, inasmuch as the object of the State Survey was the investigation of all natural resources of the State. Almost as soon as he

*Van H. Manning, Jour. Ind. and Eng. Chem., Vol. 7, No. 8, page 716, Aug. 1915.

was appointed State Geologist, he began to plan new lines of work and to call in to assist him men who were fully qualified to carry on the investigation he desired. Thus you find associated with him during the first years of his directorship of the State Survey such men as Professor George Williams of Johns Hopkins, Professor S. L. Penfield of Yale; Dr. George F. Kunz of New York; Professor F. P. Venable of the University of North Carolina; Dr. George P. Merrill of the National Museum at Washington; Professor George Swain of the Massachusetts School of Technology; Professor Thomas L. Watson of the University of Virginia; Professor H. V. Wilson of the University of North Carolina; Professor William Cain of the University of North Carolina; Mr. H. B. C. Nitze; Mr. Gifford Pinchot of Washington; Professor Heinrich Ries of Cornell, and others. The published reports of the State Survey, similar to those of the Bureau of Mines, seldom bear the name of Holmes as one of the authors.

Dr. Holmes did a great deal to broaden the scope of the State Geological Surveys, and to demonstrate that there could be and should be a close coöperation between the State and Federal Surveys. There was always most friendly coöperation between the North Carolina Survey and the Federal Survey; and, although the State received very largely from the Federal Survey, it gave very largely in return, for Dr. Holmes was always ready to give his time and energy to any work which promised to be of service to the Federal Survey; and he was often called in consultation regarding the work of that Survey. Dr. Walcott, who was then Director, states that he was early impressed with Dr. Holmes' thoroughness and the quality of his work as State Geologist. In the Geological Survey his most important work was probably the application of geology to the industrial development of the country. He started this in the State Survey but later introduced it into the Federal Survey.

As State Geologist he became very much interested in the preservation of the forests of the Southern Appalachian region and it is due largely to his work as State Geologist that the Weeks Bill was passed by Congress, which has resulted in the purchase of forest areas to be used for forest reservations in the Southern Appalachian Region, and the White Mountain Region. It was under the supervision of Dr. Holmes that the mass of evidence was collected which proved to the Congressional Committees that it was absolutely necessary for Congress to take some action to prevent the destruction of the forests of these two areas in order to protect the flow of navigable streams.

In connection with an investigation relating to our turpentine industry, he had experimental work carried on in regard to the cup and gutter method, which is now in general use in this industry. He also had investigations made as to the practicability of the reproduction of

the longleaf pine and an actual demonstration in planting of seed proved the feasibility of such reproduction.

Dr. Holmes also started the "good roads" movement in North Carolina, and one of the first publications of the State Survey was a report on "Road Materials and Road Construction in North Carolina." While his work in connection with the roads was almost entirely from the educational standpoint, yet it was this work that made it possible for his successor to obtain through the North Carolina General Assembly the creation of first a Highway Division of the Survey and later of a State Highway Commission.

In the State work Dr. Holmes also began investigations in relation to the waterpowers, mineral waters, underground water supplies, timber resources, mineral resources, and fisheries of the State; but a limited treasury and lack of time prevented him from carrying these out as rapidly as he desired, and it was left to his successor to complete some of them.

During his term of office as State Geologist, 1891 to 1905, the Survey published twenty Bulletins and Economic Papers giving the results of investigations that he had started. In 1905 the Act creating the Survey was repealed and a new Act, which was prepared by Dr. Holmes, was passed by the General Assembly of 1905. This created the North Carolina Geological and Economic Survey.

Dr. Holmes brought geology to this people and made them realize its value and application in the arts.

In connection with the investigation of the Fisheries of the State, Dr. Holmes was the leading spirit in the establishment of the Biological Laboratory at Beaufort. In June, 1897, after consultation with Dr. Holmes and Professor H. V. Wilson, of the University of North Carolina, the United States Commissioner of Fisheries established at Beaufort, North Carolina, a temporary station for the investigation of the marine fauna and flora of the Southern coast. Professor Wilson was appointed director, and for the next three years he and Dr. Holmes devoted much time and thought to its development. Congress finally made an appropriation for the establishment of a permanent laboratory, but made no appropriation for the purchase of a site. Dr. Holmes recommended a site and arranged for its private purchase and its donation to the Government. He, with Professor Wilson, drew up the outline plans for the laboratory buildings and he remained in close touch with the work of the laboratory until his resignation as State Geologist. This work of Dr. Holmes had an important bearing on the Fisheries of the State of North Carolina, as it started the interest of the people of the State in the value of the fisheries and finally resulted, some

years after the resignation of Dr. Holmes as State Geologist, in the creation of the Fisheries Commission of the State of North Carolina.

Dr. Holmes' work as State Geologist had brought him prominently before the public, and in 1903 he was chosen director of the Department of Mines and Metallurgy at the St. Louis World's Fair. He accepted this appointment and had charge of and organized that Department. He planned the exhibits and introduced new features for the exhibits which have since been adopted by all succeeding expositions. These new features made the Mines Building of the St. Louis Exposition the most successful and instructive Mining Exhibit that was ever made at any exposition. For special services rendered at this exposition he was decorated by several foreign governments. In connection with the Mining Exhibit, he suggested that an investigation be made of the fuels of the United States and was successful in persuading Congress to authorize the investigation and make the necessary appropriation with which to carry on the work. Dr. Holmes, and, at his suggestion, two representatives of the United States Geological Survey were created a committee to carry on the investigations which were made during the years 1904 and 1905. Although Director of the Department of Mines at St. Louis, Dr. Holmes continued to have general supervision of the work of the North Carolina Geological Survey. Early in 1905 the Director of the United States Geological Survey appointed Dr. Holmes to take individual charge of the Fuel Investigations, and soon after he was appointed Chief of the Division of Technology of the Federal Survey, and then severed his connection with the State Geological Survey.

While connected with the Federal Survey, Dr. Holmes examined Mine Experiment Stations and Mine-rescue Stations in Great Britain, Belgium, France, and Germany and it was the result of these studies that led to the inauguration of the movement for mine-rescue work in this country.

In 1907, President Roosevelt, on Dr. Holmes' recommendation, secured the appointment by the governments of Great Britain, Germany, and Belgium of one expert engineer from each of these countries to visit the United States and then visit with Dr. Holmes the more important coal fields of this country. This was done in order to determine to what extent the safety practices used in other mining countries might be introduced into the United States. It was on the basis of the findings of these engineers that Dr. Holmes developed and organized his investigations relating to mine explosions, etc.

In 1908, when President Roosevelt took up the question of the conservation of our natural resources, Dr. Holmes was appointed a member

of the National Conservation Commission and he had charge of the inventory of the nation's mineral resources.

In all Dr. Holmes' work his central thought had always been the development of the mining industry and the improvement of conditions affecting the miner. In carrying out these great ideas, he thought only of the object to be attained and paid little or no heed to personal attacks or opposition such as inevitably accompanies a forward movement or investigation that requires the coöperation of both the legislative and administrative departments of our government. When, however, an attack was made on him that appeared to endanger the work itself in which he was engaged, he was then ready to put forth all his efforts to meet and defeat the opposition.

Dr. Holmes was human as the rest of us and occasionally was forgetful in regard to certain things that were to be done. This characteristic of his sometimes led to severe criticism of his work by those who were not thoroughly acquainted with him. Whenever any apparent neglect on his part was called to his attention the matter was instantly taken care of and ample apology made for the oversight. Dr. Holmes was excessively careful to observe all the little courtesies of life and was a splendid representative of the Southern Christian gentleman.

Dr. Holmes was born at Laurens, South Carolina, November 23, 1859, and died at Denver, Colorado, July, 1915, after nearly a year's illness and fight against tuberculosis. His illness was undoubtedly brought on by severe exposure in connection with the examination of mines for explosions, and of hardships endured in investigations regarding mining conditions in Alaska. His parents were Z. L. and Catharine (Nickles) Holmes.

His early education was in the schools of South Carolina, but his university work was at Cornell, where he graduated in 1881, taking the degree of B. S. Later he received the degree of D.Sc. from the University of Pittsburgh, and in 1909 the degree of LL.D. from the University of North Carolina. During his college course Dr. Holmes devoted especial attention to chemistry (including the chemistry of explosives), to metallurgy, geology, general physics, and mining. He visited mining regions and metallurgical plants in many parts of the United States, Germany, France, Great Britain, and Belgium.

In the fall of 1881 he became Professor of Geology and Natural History in the University of North Carolina and held this position until 1891, when he became State Geologist.

On October 20, 1887, Dr. Holmes married Miss Jeannie I. Sprunt, of Wilmington, North Carolina.

Dr. Holmes was a fellow and charter member of the Geological Society of America, fellow of the American Association for the Advance-

ment of Science, member of the American Institute of Mining Enginers, American Society for Testing Minerals, and American Society of Mechanical Engineers; he was appointed a member of the Mining Legislation Committee of Illinois; one of the founders of the Elisha Mitchell Scientific Society; member of the Sigma Xi Scientific Society; member of the Washington Academy of Science, St. Louis Academy of Science, and the North Carolina Academy of Science; member of the Cosmos Club of Washington and the Engineer's Club of New York.

In closing this sketch, let me further express my feelings and thought regarding Dr. Holmes in the words of several friends who were very close to him:

Dr. Holmes stands as one of the finest examples of unselfish devotion to the cause which he championed, even to the extent of giving his life for it. Mining in America in its national aspect is more deeply indebted to him on its scientific, operating, and industrial sides than to any one other individual. It seems most unfortunate that Dr. Holmes did not live to aid the movement to improve the laws affecting mines and mining; but, with the Bureau of Mines firmly established and coöperating with the thoughtful mining engineers and operators throughout the country, the results he hoped to see should be speedily obtained. CHARLES D. WALCOTT.

Ever thoughtful, resourceful, a great organizer, a clear, logical and eloquent speaker, a splendid judge of men and their capacity to do the work his master mind had planned, the U. S. Bureau of Mines, founded only in 1910, has under his leadership rapidly grown to be one of the most important of all government agencies. . . .

His monument is the U. S. Bureau of Mines, and his memory will be cherished forever in the hearts of countless miners whose lives he has rendered safer in the perilous occupation they follow and without the product of whose busy hands our present civilization could not exist. Although cut down in but little beyond the prime of life, he has left us an example of what glorious achievements, indomitable will, and untiring work can accomplish. The great Bureau he so largely created and so successfully directed will continue its brilliant work along the path he so skillfully blazed, since, thanks to a very able and conscientious Secretary of the Interior, his successor is in thorough accord with the high ideals of the former Chief, and was ever his efficient helper. I. C. WHITE.

In the death of Dr. Holmes the people of the United States lose one of their most remarkable and efficient public servants. And the saddest part of it all is that Dr. Holmes is a victim of overwork, a too great devotion to the duties which had been assigned to him in behalf of the safety of the million miners in the United States. He was one of the most enthusiastic, indefatigable workers I ever had the pleasure of associating with. His mind was continually upon the yearly death toll of the miners, and although taken away in the prime of his life, he has already accomplished much in reducing the

terrible death rate. In the last five years of his life he saw a slowly but steadily decreasing death rate, and while it gave him much joy, it only added to his almost superhuman efforts in behalf of the men.

VAN H. MANNING.

A full list of Dr. Holmes' reports and more important scientific papers are given in his Bibliography, which is given at the close of this sketch.

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21. *Notes on the Underground Supplies of Potable Waters in the South Atlantic Piedmont Plateau.* Am. Inst. Min. Eng. Trans., Vol. XXV, pp. 936-943, and Jour. Elisha Mitch. Sci. Soc., Vol. XII, Pt. 1, 1895, pp. 31-41.
22. *Corundum Deposits of the Southern Appalachian Region.* Seventeenth Ann. Rept., U. S. Geol. Survey, Pt. 3, 1896, pp. 935-943.
23. *Gold in the Carolinas.* Gold Fields Along the Southern Railway. Published by the Southern Railway, 1897, pp. 8-19.
24. *Mica Deposits of the United States.* Bull. Geol. Soc. Am., Vol. X, 1898, pp. 501-503.
25. *North Carolina Mineral Industry in 1898.* Eng. and Min. Jour., Vol. LXVII, 1899, pp. 50-51.
26. *Mica Deposits in the United States.* U. S. Geol. Survey, Ann. Rept. XX, 1899, pp. 691-707.
27. *Waterpower in North Carolina.* (With Geo. F. Swain and E. W. Myers.) Bull. 8, N. C. Geol. Survey, 1899, 362 pp.
28. *Some Recent Road Legislation in North Carolina.* Economic Paper No. 2, N. C. Geol. Survey, 1899, 24 pp.
29. *The Deep Well at Wilmington, North Carolina.* Jour. Elisha Mitch. Sci. Soc., Vol. XVI, Pt. 2, 1899, pp. 67-70; Science N. S. XI, 1900, p. 128.
30. *Mica Industry in North Carolina in 1900.* U. S. Geol. Survey, Min. Res., 1900, pp. 853-954.
31. *The Cretaceous and Tertiary Section Between Cape Fear and Fayetteville, North Carolina.* Science, N. S., Vol. XI, 1900, p. 143.
32. *Recent Road Legislation in North Carolina.* N. C. Geol. Survey, Economic Paper No. 5, 1901, 47 pp.
33. *Proceedings of the North Carolina Good Roads Convention.* U. S. Dept. Agric. Office of Public Road Inquiries. Bull. No. 24, 1903, 72 pp.
34. *Road Building in North Carolina.* U. S. Dept. Agric. Office of Public Road Inquiries. Bull. No. 24, 1903, pp. 65-71.
35-41. *Biennial Reports of the North Carolina Geological Survey.* 1891-92; 1893-94; 1895-96; 1897-98; 1899-1900; 1901-02; 1903-04.
42. *The Collection of Mineral Statistics in the United States of America.* Cong. int. d'expansion econ, mondiale, Mons, 1905, sect. 2, Statis, int. Bruxelles, 2 pp.
43. *Fuel Investigations, Geological Survey; Progress During Year Ending June 30, 1909.* Proc. Amer. Soc. Test. Materials, Vol. IX, 1909, pp. 619-625.
44. *Inspection of Mines.* Rep. of Proc. Amer. Min. Cong., 12th ann. sess., Goldfield, Nev., Sept. 27-Oct. 2, 1909, pp. 236-238.
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46. *A Rational Basis for the Conservation of Mineral Resources.* Bull. 29, Amer. Inst. Min. Eng., May, 1909, pp. 469-476.
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48. *The Bureau of Mines and Its Work.* Rep. of Proc. Amer. Min. Cong., 13th ann. meeting, Los Angeles, Cal., Sept. 26-Oct. 1, 1910, pp. 219-227.

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54. *The Sampling of Coal in the Mine.* Tech. Paper 1, U. S. Bureau of Mines, 1911, 18 pp.

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58. *The National Phases of the Mining Industry.* 8th Int. Cong. Applied Chem., Vol. XXVI, 1912, pp. 733-750.

59. *Speech Concerning Work of the Bureau of Mines.* Rep. of Proc. Amer. Min. Cong., 17th ann. meeting, Phoenix, Ariz., Dec. 7-11, 1914, pp. 95-96.

60. *Parker, E. W., Holmes, J. A., and Campbell, M. R., Preliminary Report on Operations of Coal-Testing Plant of United States Geological Survey at Louisiana Purchase Exposition, St. Louis, Mo., 1904.* Bull. 263, U. S. Geol. Survey, 1905, 172 pp.

61. *Report on Operations of Coal-Testing Plant of United States Geological Survey at Louisiana Purchase Exposition, St. Louis, Mo., 1904.* Prof. Paper 48, U. S. Geol. Survey, 1906, 3 Vols.

62. *United States Geological Survey. Preliminary Report on Operations of Fuel-Testing Plant of United States Geological Survey at St. Louis, Mo., 1905; J. A. Holmes in Charge; Introduction and Chapter on "Briquetting Tests" by J. A. Holmes.* Bull. 290, U. S. Geol. Survey, 1906, 240 pp.

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65. *With Moldenke, R. G. G., Belden, A. W., and Delamater, G. R. Washing and Coking Tests of Coal and Cupola Tests of Coke Conducted by United States Fuel-Testing Plant at St. Louis, Mo., Jan. 1, 1905, to June 30, 1907, with Introduction by J. A. Holmes.* Bull. 336, U. S. Geol. Survey, 1908, 76 pp.

66. *With Humphrey, R. L. Organization, Equipment, and Operation of the Structural-Materials Testing Laboratories at St. Louis, Mo., with a Preface by J. A. Holmes.* Bull. 329, U. S. Geol. Survey, 1908, 84 pp.

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68. *With Griffith, William, and Conner, E. T. Mining Conditions Under the City of Scranton, Pa., Report and Maps, with a Preface by J. A. Holmes and a Chapter by N. H. Darton.* Bull. 25, U. S. Bureau of Mines, 1912, 89 pp.
69. *United States Congress, House of Representatives; Committee on Mines and Mining. Hearings Before Committee, Jan. 11, 1912; Contains Statement of J. A. Holmes, Director of Bureau of Mines, on Existing Law and New Bill Proposed to Meet Claims of Western Mining Men.* Wash., D. C., Govt. Printing Off., 1912, 48 pp.
70. *Hearing Before Committee, 62d Cong., 2d Sess., on H. R. 17260, An Act to Amend An Act Entitled "An Act to Establish in Department of Interior a Bureau of Mines," Approved May 16, 1910, June 12, 1912; Contains Statement of J. A. Holmes, Director of Bureau of Mines.* Wash., D. C. Govt. Printing Off., 1912, pp. 4-16.
71. *With Lord, N. W. Analyses of Coals in United States with Descriptions of Mine and Field Samples Collected Between July 1, 1904, and June 30, 1910, with Chapters by J. A. Holmes, F. M. Stanton, A. C. Fieldner, and Samuel Sanford.* Bull. 22, U. S. Bureau of Mines, 1913, 2 Vols., text and plates.
72. *Rutledge, J. J. The Use and Misuse of Explosives in Coal Mining, with a Preface by J. A. Holmes.* Miners' circ. 7, U. S. Bureau of Mines, 1913, 53 pp.
73. *United States Congress, House Representatives; Committee on Mines and Mining. Hearing (on H. R. 6063, Appropriation for Mining Schools)* 63d Cong., 2d Sess., Dec. 4, 1913; contains statement of J. A. Holmes, Director of Bureau of Mines. Wash., D. C., Govt. Printing Off., 1913, 19 pp.
74. *Committee on Public Lands. Hearing on Bill H. R. 13137 to Provide for Leasing of Coal Lands in Territory of Alaska, and for Other Purposes,* Feb. 23 to 26, 1914; contains statements of J. A. Holmes, Director of Bureau of Mines, with an abstract of all bills on opening of coal lands in Alaska. Wash., D. C., Govt. Printing Off., 1914, Pt. 2, 267 pp.
75. *United States Navy Department. Report on Coal in Alaska for Use in United States Navy; Report of Survey and Investigation by Experimental Tests of Coal in Alaska, Etc.;* contains general statement by J. A. Holmes, Director of Bureau of Mines. House Doc. 876, 63d Cong., 2d Sess., 1914, 123 pp.

FINANCIAL STATEMENT

There is given below a statement which shows the receipts and expenditures of the North Carolina Geological and Economic Survey for the two years ending November 30, 1916, grouped together according to subjects investigated during this time. These are arranged separately for the two years. The receipts cover moneys received from the State Treasury, representing the annual appropriation, and other sums received from individuals for coöperative work of various kinds, as indicated, and from other sources:

DECEMBER 1, 1914, TO NOVEMBER 30, 1915

Receipts

Balance on hand	$ 1.78
Annual appropriation	10,000.00
Annual appropriation for roads	5,000.00
Cash from U. S. Office of Public Roads on account of road work	60.00
Cash from American Association of State Highway Officials for postage	15.00
Cash covering freight on road oil	5.47
Cash from University on account of Road Institute	28.68
Cash on account of reporting of Drainage Convention at Wilson	33.30
Cash from Canton on account of expenses of H. B. Varner	15.04
Cash from transportation of reports	3.74
Cash from reimbursement of freight by Southern Railway	2.10
Subscriptions for forest fire patrol work	327.00
Cash from State Fair on account of installation of exhibit	73.09

Disbursements

General geological and mineralogical investigations	$ 831.87	
Coastal Plain geological investigations	75.00	
Good Road investigations	5,319.45	
Forestry investigations	2,616.04	
Coöperative forest fire patrol work	327.00	
Drainage investigations	599.28	
Fish and oyster investigations	75.00	
Geological Board expenses	83.05	
Clerical and editorial work	4,316.83	
Other office expenses	1,269.23	
Interest and tax on notes covering loans	49.50	
Balance on hand	2.95	
	$15,565.20	$15,565.20

DECEMBER 1, 1915, TO NOVEMBER 30, 1916

Receipts

Balance on hand	$ 2.95
Annual appropriation	10,000.00
Annual appropriation for roads	5,000.00
Cash from N. C. Drainage Association, stenographic work	20.00
Cash from American Association of State Highway Officials for postage, duplicating, telegrams, etc	64.28
Cash from Southern Railway for disbursement of freight	31.50
Cash from Southern Appalachian Good Roads Association for duplicating and clerical work	22.50
Cash from U. S. Office of Public Roads on account of coöperative road work	75.00
Cash from Battle Memorial Committee for postage	3.83

Cash from Austin Brothers on account of freight and setting up machine at Road Institute	15.00
Cash from N. C. Forestry Association for stenographic work	25.00
Cash from State Highway Commission on account of freight on road models	13.30
Cash from State Highway Commission on account of expense of Road Institute	46.16
Reimbursement on account of Hickory Nut Gap Road account	27.00
Cash from National Association of Fisheries Commissioners for telegrams	7.65
Cash from N. C. Good Roads Association for clerical work and postage	48.54
Cash from N. C.-Tenn. Boundary Commission for postage and clerical work	46.54
Cash from Miss Greenwood on account of reimbursement on account of salary	15.25
Cash from State Fair Association on account of expense of installation of exhibit	101.85
Subscriptions for coöperative forest fire work	669.63
Cash by mistake from N. C. Forestry Association	50.00

DISBURSEMENTS

General geological and mineralogical investigations	$ 1,070.60	
Good Road investigations	5,065.50	
Forestry investigations	3,271.06	
Coöperative forest fire patrol work	629.63	
Returned to Forestry Association amount deposited by mistake	50.00	
Drainage investigations	585.00	
Fish and oyster investigations	75.00	
Geological Board expenses	73.21	
Clerical and editorial expenses	3,525.04	
Other office expenses	1,898.73	
Interest and tax on notes covering loans	41.73	
Balance on hand	.48	
	$ 16,285.98	$16,285.98

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*

2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*

3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*

4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*

5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*

6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*

7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Postage 5 cents.*

8. Water-powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*

9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*

10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*

11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Out of print.*

13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Out of print.*

14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*

15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 10 cents.*

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Postage 6 cents. Cloth copies 50 cents extra.*

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*

18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy, 50 cents extra.*

19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water-powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 50 cents extra.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 50 cents extra.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, ... pp., ... pl., ... maps. *Postage .. cents. In press.*

27. The Altitudes of North Carolina, 1917. 8°, ... pp. *Postage .. cents. In press.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Postage 2 cents.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a List of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of Clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Postage 4 cents.*

Gives description of Mines worked for Gold in 1903; description of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives; Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Assocated Minerals, Localities, Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Postage 4 cents.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interest in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper and Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analysis of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Postage 7 cents.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica Deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; Some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Out of print.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911 by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Postage 10 cents.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new milling process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine. including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report of the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc.; the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp. *Postage 15 cents.*

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and The North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest-Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection held as part of the Conference on Forestry and Nature Study, Montreat,

N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. *Postage 15 cents.*

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, .. pp. *In press.*

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. *In press.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy $1 extra.*

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Vol. IV.—The Birds of North Carolina—*In press.*

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving Object and Organization of the Survey; Investigations of Iron Ores, Building Stone, Geological Work in Coastal Plain Region, including supplies and drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

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Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

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Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

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Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the Survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 165 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on the forest fire conditions in the northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, ... pp. *Postage .. cents.*

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